THURSDAY, JULY 1, 1886

KEPLER'S CORRESPONDENCE WITH HERWART VON HOHENBURG

Ungedruckte wissenschaftliche Correspondenz zwischen Johann Kepler und Herwart von Hohenburg, 1599. Ergänzung zu: Kepleri Opera Omnia, ed. Chr. Frisch. Nach den MSS. zu München und Pulkowa edirt von C. Anschütz. (Prag: Victor Dietz, 1886.)

HERWART VON HOHENBURG was a highly stimulating correspondent. His scientific curiosity was insatiable; his official duties as Bavarian Chancellor precluded personal research; and he accordingly deputed to the busy brain of Kepler the working out of problems which engaged his scanty leisure, while baffling his powers. The pressure of his demands was, indeed, so severe that Kepler at times bewailed himself in confidential quarters over the grinding labours they imposed upon him: but he could ill afford to quarrel with a patron who was as generous as he was inquisitive; and he thus continued to evolve for his benefit the stores of curious learning and adventurous theory of which some considerable specimens have lately been unearthed, and are now presented to the public.

The correspondence took its origin from the publication, in 1596, of the "Mysterium Cosmographicum," by which Herwart's admiring attention was drawn to the speculative young "mathematicus" of the Styrian States; and continued from October 1597 to December 1609. There was, however, a gap in its records. Three letters, known to have been written by Kepler to Herwart in the year 1599, were not forthcoming. Dr. Frisch, the late indefatigable editor of Kepler's "Opera Omnia," gave up the search as hopeless; and the detection of the latitant documents became possible only with the correction, in a new printed catalogue of the manuscript collections in the Munich State Library, of an error in the old printed one,—an example, were such needed, of the uses to historical research of the least inviting bibliothecarian drudgery. The opportunity for discovery was promptly turned to account by M. Carl Anschütz, the editor of the present *brochure;* who deserves the acknowledgments of every one interested in scrutinising the workings of a most singularly and brilliantly constituted mind, not alone for the zeal of his inquiries, but also for the elaborate care with which he has set forth their results, rendering intelligible by copious annotations what must otherwise have remained, to the vast majority of readers, hopelessly obscure.

The truth chiefly emphasised by a perusal of these remarkable letters is that of the inextricable entanglement of Kepler's mystical with his scientific views. Many men have speculated wildly while investigating acutely; Kepler alone, perhaps, investigated acutely *because* he speculated wildly. His visions of abstract beauty and order in a neatly fenced and finished universe warmed his fancy, and inspired and lightened labours which would otherwise have been insupportable. His discoveries were the fruit of his illusions, because his illusions were faithfully and unwearyingly confronted with the realities of nature. He was a dreamer; but he was not content to leave his dreams undisturbed by facts. Hence his superiority—

ἔξοχος Ἀργείων κεφαλήν τε καὶ εὐρέας ὤμους—

to the common run of Pythagorean enthusiasts, and hence his great name in scientific history.

The topics discussed in the present correspondence forcibly illustrate the compound nature of his mind, no less visionary in its instincts than positive in its methods. They include the theory of eclipses, the *rationale* of planetary influences, the harmonic relations of planetary velocities, the date of the birth and the horoscope of Augustus, the nature of terrestrial magnetism, and the position, actual and primitive, of the north magnetic pole. The first of the three letters is dated from Gratz, April 9 and 10, 1599. It opens with a pompous eulogium on Tycho Brahe. "Taceant omnes, et Tychoni Brahe Dani auscultent." Nor does it detract, we are told, from his merits to have taken a wrong theoretical turn. His hostility to the motion of the earth nowise impairs the excellence of his observations and instruments. Each astronomer is free to embrace, without discredit to his skill and erudition, whatever "religion of movement" seems best to himself. "Sed ad rem."

Tycho, deceived no doubt by reports of coronal splendours (he had never himself witnessed the phenomenon), had denied the possibility of a total solar eclipse, the moon suffering, he alleged, a diminution of one-fifth of its apparent diameter when projected on the sun. Kepler, while unconvinced of the fact, was at no loss for an explanation. A dense lunar atmosphere, powerfully reflective of the sun's rays, while partially permeable by them, was invoked by him to augment the seeming dimensions of the full moon, and throw a kind of subdued glory round the eclipsed sun. The perplexity started by Tycho was not, however, so easily allayed. It kept cropping up at intervals; and led eventually both to Kepler's optical researches, and to what we may call his discovery of the corona, as an actual fact to be reckoned with by science. The eclipse observed by Clavius at Rome in 1567 he showed to have been unquestionably total; the sun was fully covered by the moon; yet an unlooked-for radiance survived ("Op. Omnia," t. ii. p. 318). He accounted for it by the illumination of an "ethereal substance" in the solar neighbourhood, "not altogether nothing, but possessing some measure of density"; nor have we yet got much beyond the approximate ratification of his conjecture.

Later in life Kepler formally laid down his arms before the lunar theory, after spending enormous labour on the effort to bring it into conformity with his Laws. But here, in these long-missing letters, he unexpectedly emerges as the discoverer of the moon's annual equation. The fact seems to admit of no doubt; his words are explicit. The discrepancies between the observed and calculated times of eclipses compelled the correction. Had not Copernicus, he remarks, been occupied with greater things, he must have introduced the same "annual inequality" depending upon the eccentricity of the earth's orbit. "What he neglected," he adds, "I now do." The chief merit of this important advance has usually been ascribed to Tycho. He had doubtless glimpses of its necessity, but omitted to follow them up. The earliest explicit declaration hitherto known in favour of introducing such a correction was contained in a letter from Kepler to Bernegger of June 30, 1625 ("Op. Omnia," t. vi. p. 618). It now appears, not only that the conclusion was an entirely original one, but that he had arrived at it twenty-six years previously. M. Anschütz promises some further elucidations of the point, which we await with interest.

One of the most curious chapters in Kepler's mental history is furnished by his attitude towards the astrological superstitions of his time. Herwart, as a good Catholic, had condemned them; his correspondent made out a case in reply. His contention, it is true, was not on behalf of the vulgar charlatanry of the science. This he admitted to be indefensible, save on the one poor plea of stringent necessity. Providence, as he wrote to Maestlin, which had denied to no animal the means of preserving its life, had assigned, for that end, astrology to the astronomer. He must draw horoscopes and publish prophesying calendars, or cease to exist. Thus only could he obtain means to pursue nobler studies. The people, while giving their money for the lies they loved, unconsciously promoted the truth they were indifferent to. It was an involuntary, but none the less efficacious, "endowment of research."

So Kepler filled his empty pockets, and satisfied his conscience by professing incredulity in his own vaticinations. They proved, nevertheless, and, as it were, in his own despite, highly successful. Not a few of them stumbled felicitously into fulfilment. Some art, or luck, drew them, now and again, into conformity with the future. And since, as their author himself remarked, the game is one in which the hits count, but the misses are forgotten ("Das Treffen behält man, das Fehlen aber vergisst man") his reputation as a seer rose high, and brought him in the best and only sure part of his income.

There was, however, a recondite species of planetary influence believed in by Kepler as part of the eternal order of things. By the belief, indeed, his whole career of investigation was profoundly influenced; for the effort to justify it led him into a track of thought which finally conducted him to the Third Law. One of the chief points of interest in the present correspondence is that it discloses the time and manner of his entrance upon that track. "Lift up your ears to listen: Eureka!" he wrote to Maestlin, August 29, 1599; and to Herwart, August 6, he solemnly announced his invention of a "theorema jucundum," in which was concentrated the whole secret of the music of the spheres. Already he gives the title ("de Harmonia Mundi"), and, to a certain extent, the plan, of the great work published twenty years later. It was conceived, as we now see with additional clearness, less under the influence of sober truth-seeking, than in the fervour of illusive speculation. Essentially, it was a piece of brilliant extravagance. That the harmonic law of periods and distances should have been found as a nugget amid such worthless, though shining debris, is one of the oddest facts in the history of science.

The theory of planetary harmonies was struck out by Kepler as an adjunct to his peculiar theory of planetary aspects. It might in fact be called its dynamical counterpart. Geometrical relations of movement were substituted in it for geometrical relations of position. The velocities of the six planets were, he averred, so connected that, were there an inter-planetary medium capable of conveying audible vibrations, a celestial chord of the sixth and fourth would perpetually resound through space. The intellectual perception of potential harmonies sufficed, however, for the delectation of the rational creatures appointed to enjoy them; while, similarly, the intellectual apprehension of "aspects" affected, primarily, the sentient "soul of the world," and, secondarily, through the varying moods thus impressed by the stars, the course of sublunary affairs. The third letter to Herwart is mainly filled with details of Kepler's persevering efforts to complete and fortify the visionary analogy between astrological aspects and musical intervals.

Yet even here, in this region of intangible speculation, his innate respect for facts did not desert him. What autobiographical details he left, we owe to his desire to compare his life as it was with what, astrologically, it ought to have been. And the first of the present letters contains a highly curious little bit of self-study, illustrative of the depressing effects of "Saturn in sextile with the Sun" at the hour of nativity. Here is Kepler described by himself, ætat. twenty-seven.

"A body of no ample proportions, lean and scraggy; a mind unaspiring, that is to say, burying itself in literary nooks and crannies, suspicious, timid, tending towards, and abiding in difficulties and knotty points; manners to correspond. Sour and sharp flavours, the gnawing of a bone, the devouring of dry bread, form my gustatory delights; my keenest ambulatory joy is to traverse steep and rugged paths, to mount hills, to pierce my way across dense thorn-brakes. Pleasure in life other than in study I neither have nor desire; proffered, I reject. My fortune matches my tastes to a hair. Where others might abandon hope, I find access to achievement and fame. Yet not over spacious; for my advance is continually checked, and my circumstances change without mending. All my efforts have hitherto met with strenuous resistance. It may be that social sympathy will ever be denied me while I irritate mankind by advocating the movement of the earth, while

"tanti ponderis orbem
Obnixa cervice cito per sidera lapsu
Incito, terricolûm contra nitente senatu."

A. M. CLERKE

UPLAND AND MEADOW

Upland and Meadow, a Poaetquissings Chronicle. By Charles C. Abbott, M.D. (London: Sampson Low, Marston, Searle, and Rivington, 1886.)

THIS is a very pleasantly written book by an author who may be justly regarded as a kind of American Gilbert White. We may as well inform our readers at once that the district of which the natural history is herein chronicled is situated by a little stream which empties itself into the River Delaware, and that the name, which will appear to English readers somewhat difficult of pronunciation, is of Indian origin. There are fourteen chapters in the work, and an index which is to be strongly commended for its completeness. It is really a most important feature in a book of this kind to have a good index, and in insisting upon this necessity we are intentionally paying a complimentary tribute to the author, because there is a large amount of valuable observation which readers should have occasion to refer to after the first perusal of the work, but which would be lost without such an index, owing to the necessarily disjointed mode of treatment entailed by an adherence to seasonal records. We need only refer to the early editions of Kirby and Spence's "Introduction to Entomology" as an example of a work containing a large collection of facts and observations rendered almost useless for want of an index.

Dr. Abbott is evidently a close observer, and English naturalists will derive both pleasure and profit by a perusal of his chronicle. It is rather to be regretted that he has confined himself so much in the text to the local trivial names of the animals and plants of his district. It places English readers at a disadvantage, for example, to have to turn to the index each time a species is mentioned in order to find out what is referred to under such names as "grakles," "quaker-girls," "quahog," or "scuttle-bug." But this is, after all, a matter of small importance, because the scientific names will be found in the index, and the criticism is made only on behalf of that large circle of readers in the old country which the work ought to attract, and to which it appeals through its English publishers.

The author's strong point appears to be ornithology, but his sympathies are fairly distributed, and his observations are recorded in a pleasant, chatty style which is sure to be attractive to general readers :—

"To realise what a wealth of animal and vegetable life is ever at hand for him who chooses to study it, let a specialist visit you for a few days. Do not have more than one at a time, or you may be bewildered by their enthusiasm.

"I have had them come in turn—botanists, conchologists, microscopists, and even archæologists. What an array of names to strike terror to the breasts of the timid ; yet they were all human, and talked plain English, and, better than all, were both instructive and amusing."

As a specimen of the author's style we give the following from Chapter II., entitled "Poaetquissings in Winter."

In order to carry on observations without frightening the denizens of the creek, the author was in the habit of lying down upon the ice, covered over with a blanket so as to be able to see into the frozen depths. The terrestrial life soon became accustomed to his presence, and at length became inquisitive. "This was amusingly illustrated in one instance by a weasel, in crossing the creek on the ice, stopping to investigate the peculiar something lying in its path. Peering under the blanket, it either heard my blood circulating or smelled it. At all events it gave my ankle a nip which brought me quickly to my feet, and sent the bloodthirsty wretch scudding over the ice with marvellous rapidity. How the crows laughed! I had noticed a flock of these birds when I went to the creek, and had been wondering if their incessant cawing was not a discussion of my curious movements. They were, possibly, disposed to think me a trap laid for them, but were astonished or amused at my sudden regaining of the perpendicular when the weasel offered to investigate the matter."

In the third chapter, "Twixt Cold and Heat," will be found a good collection of observations and experiments bearing on the subject of instinct, with special reference to the nesting of birds. Whether the author's views on this much-vexed question will command assent we cannot undertake to say, but whether we differ from his conclusions or not, his experiments are certainly worthy of serious consideration. Among these we have a series of experiments with a chromo-picture of a cat, with a mirror, and with coloured yarns, the latter having for their object the testing of the sense of colour. In the case of a Baltimore oriole in course of building its nest, a decided choice was exerted—red, yellow, purple, and green yarns having been refused, and gray only selected, till the nest was nearly finished, when a few of the purple strands were used. Other amusing experiments on the transference of eggs are described in this same chapter.

With reference to the subject of migration the author states in Chapter IV., on "Marsh Wrens," that "temperature and migration are largely coincident, but cannot be considered as cause and effect." He further adds that certain rules respecting the habits of American birds which had been regarded by previous observers as fixed and invariable, are quite variable if observations are only continued over a sufficiently long period of time. "The results of a single year will have but little bearing upon the regularity or want of it in a bird's movements. The observations of the same person in the same locality must extend over at least a decade before it is safe to arrive at any general conclusions." We commend this passage to the members of our county field clubs who are in want of material for observation.

Space will not permit us to make any lengthy extracts from the book, but we cannot refrain from calling the attention of the bird-destroyers of this country to the admirable "apology" for the grakle (*Quiscalus versicolor*) which the author makes in the fifth chapter. These birds were formerly regarded as enemies to agriculture, owing to their habit of feeding upon ripe grain, which led to their being dubbed by the unpopular name of "maize thieves." But, according to Dr. Abbott's observations, it is at least doubtful whether, on the whole, man does not profit more by the existence of these birds than is lost by the attack upon the grain. To get an idea of the amount of insect food consumed by a pair with five young, he observed the birds for two hours (10 to 11 a.m. and 2 to 3 p.m.), during which time thirteen trips were made by each bird, each returning with an insect every time. The young thus got a "square meal" at least every ten minutes. The feeding goes on for ten hours per diem till the young are twenty-five days old, when they leave the nest, so that during this period each young bird has been supplied with 1300 insects, or 6500 altogether. The eleven nests in the colony under observation were supplied, therefore, with 71,500 insects, and as seven pairs in the colony raised second broods, a further supply of about 45,500 insects was "requisitioned," thus bringing up the total number consumed by one colony of birds to the enormous total of 117,000, or, including the food of the parent birds, about 150,000 "forms of insect life destroyed, all of which would have proved more or less destructive to the growing crops." We hope that the lesson taught by this observation will not be lost upon those who fail to see in persecution by birds a sufficient cause for the marvellously perfect cases of adaptive resemblance so common among insects.

Apropos of the extermination of plants, Dr. Abbott remarks (p. 41) with respect to the witch-hazel (*Hamamelis virginica*):—"Bent twigs of this plant are still used by the 'gifted' to find water, lost farming tools, and, by one enthusiast, Indian graves. The faithful still claim it as efficacious, and he who doubts is sneered at if he expresses his opinion. All that the rambler can ask is that the plant be not exterminated, and that the fools may be." We may perhaps echo this sentiment on this side of the Atlantic without offence to the members of "Primrose" or any other floral "Leagues." A protest against the extermination of rare plants by "dealers" was circulated by the Corresponding Societies Committee of the British Association last year.

We have given a sufficient idea of this work to commend it to the notice of English naturalists, and we may remark in conclusion that, although the animals and plants referred to are not familiar to the ramblers by our own streams, the sparkling anecdotal style will cause the volume to be enjoyed by all, whether trained observers or casual country wanderers, and the spirit in which the author goes forth into the fields and woods or saunters by his favourite "Poaetquissings" may be well imitated by the numerous field naturalists now being called into activity by the widely-spread establishment of local societies. "He who has this interest in the life about him can never be lonely, wander wheresoever he will, nor return from a contemplative ramble other than a wiser and happier man." R. M.

LETTERS TO THE EDITOR

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

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

On Refractometers

I OBSERVE that in your issue of June 17 (p. 157) there is an article by Mr. Gordon Thompson on "The Determination of the Index of Refraction of a Fluid by Means of the Microscope." The method there described was, I believe, first proposed by the Duke de Chaulnes in 1767; and in 1876 was suggested by Dr. Royston Pigott in connection with his refractometer. It was employed in 1878 by Dr. Sorby for recognising the minerals in thin slices of rocks; and in 1884 by Dr. Bleekrode in determining the refraction of liquefied gases (*Proc.* Royal Society, vol. xxxvii. p. 343). In these two instances the ordinary method was unavailable. The proposed method has not been much used owing to the fact that the index of refraction cannot be at all depended upon beyond the third place of decimals.

Mr. Thompson considerably exaggerates the difficulty of the usual method by means of a hollow prism: the angle of the prism may be determined once for all; the position of minimum deviation presents no difficulty; and the use of monochromatic light is unnecessary. Indeed it would be objectionable, as it would prevent the determination of the dispersive power, which is often of equal importance with the refractive power of the substance. In my own experiments I have often taken observations both of the refraction and dispersion of five or six liquids during the course of an hour, including the cleaning of the prism between each.

The suggested method seems scarcely to admit of determining the temperature of the drop with any accuracy, which is an important matter where liquids are concerned. It may, however, doubtless be employed by those who have a good microscope, where great accuracy is not required.

There is an instrument called Abbe's refractometer, which I have recently used for preliminary determinations, and I find it gives accurate results to the third place of decimals. It is founded on the principle of total reflection. It requires also only a drop of the liquid, and as the index of line D is read off without any calculation a complete determination can be made in a minute or two. There is also an arrangement by which the dispersion D to F can be observed and calculated, but I do not find that this is accurate enough to be of much service. The instrument is to be obtained of Carl Zeiss of Jena.

17, Pembridge Square, June 26 J. H. GLADSTONE

Luminous Boreal Clouds

DURING the past two or three years what appears to the writer a distinct class of luminous night clouds in the north sky have occupied his attention. They have probably not escaped more competent observers, and been perhaps referred to simple auroral phenomena, thus escaping discussion. A very marked example was visible here the night before last (22nd inst.), of which inclosed is an illustration from a sketch at the moment.

I may premise the sky was generally clear, stars bright, temperature very low, and wind strong (N.B.) from north-west—a direction maintained for the past two days. Only a slight degree of illumination was imparted to the clouds by a low moon in the south-east, near last quarter. Some light cirrus "scud," high up, conformed to direction of wind.

Above and behind a dark but very limited bank of strato-cumulus, a luminous cloudlet of brilliant pearly lustre appeared, not concurrent exactly with either the magnetic or true meridians, in altitude from 5° to 10° from the horizon, and for 7° in horizontal arc. Its shape, character, and position little varied during observation from 11.30 p.m. to 2 a.m. The structure in this case (only partially realised in the sketch) was striated, the "strike" of main streaks being north-east and south-west. *Transverse bars of luminosity conformed closely to the direction of the cirrus clouds above, and of the wind.* On the three or four other occasions of such observations these luminous cloudlets have been devoid of structure, but in every case they have presented, as in this, an opaque pearly lustre, with definite outline.

Of an entirely different type to the eye are the sudden, diffuse, variable, and transient transparencies of auroræ. Avoiding premature discussion, one cannot but suspect the former occur in much lower and less rare sky-tracts probably than the latter, with a possible frictional factor in their development; and might be distinguished as *nub.culæ borealis* if accorded a special place on further observation. The temperature has been keeping low, and sunset after-glows have in some degree reappeared during the past week; especially gorgeous being the cloud-tints at sunset of the 22nd inst. D. J. ROWAN

Dundrum, co. Dublin, June 24

Ampère's Rule

WITH regard to Ampère's rule I should be glad to know what is the general experience of actual teachers?

I have taught electricity to boys for four years, and when at Rugby I learned the subject for I think two years. My experience has been that "Ampère's rule" is *not* confusing; and as a teacher I find it best to give both this rule and the "screw-motion" rule. I see that Mr. Cumming gives both, on p. 222 of his book. W. L.

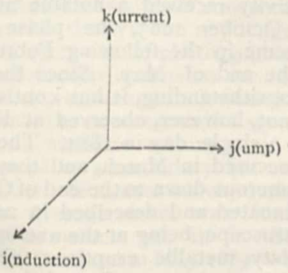
The College, Cheltenham

As Prof. Daehne (NATURE, June 24, p. 168) has called attention again to the treatment of Ampère's rule in my "Electricity Treated Experimentally," perhaps you will allow me to point out that the rule given by Ampère is quoted *historically* only, and for it is substituted a rule, due, I believe, to Clerk-Maxwell, which seems to me preferable to either the original rule of Ampère, or to that quoted by Prof. Daehne, namely, that the movement of a north pole is right-handed to the direction of the current. That is to say, if we assume any right-handed screw to be propelled along the current, the north pole will move in the direction of the twist in the muscles of the wrist in propelling it; and *vice versâ*, if the north pole move in the direction of propulsion, the current urging it will be in the direction of twist in the muscles of the wrist. In treating the movement of a conductor carrying a current in the magnetic field, I have used a rule identical in character with Ampère's, and that was probably the rule to which J. T. B. referred in his critique, namely, that a figure swimming in the current and looking along the lines of force is carried to his left. I should be glad to find a rule at once as complete and more simple, although after a pretty wide experience, not always with the very brightest of pupils, I have not been sorely pressed with the difficulty J. T. B. seems to have felt. All the required attitudes are pretty familiar to a boy who is accustomed to diving in the water and swimming on his front, side, or back. L. CUMMING

Rugby, June 24

THE following version of Ampère's Rule is one which I communicated some time ago to a few friends, but it did not appear to me to be expressed in language sufficiently grave to justify its publication. Still, as the Rule is a simple and useful one, your readers, in general, may be disposed to overlook its levity.

Draw the three well-known Hamiltonian vectors, i, j, k. After i put (nduction), after j put (ump), and after k put (urrent). Then the figure explains the action of magnetic induction on an electric current. The figure in fact asserts that i(nduction) in i makes k(urrent) in k to j(ump) along j.



Of course the same figure gives the direction (according to the Law of Lenz) of the current generated by a motion (*i.e.* a jump) of a conductor in a given direction in a magnetic field in which the direction of the induction is given.

R.I.E. College, Cooper's Hill GEORGE M. MINCHIN

An Earthquake Invention

IN my letter to NATURE, vol. xxxiii. p. 438, I clearly showed that the supposition of Mr. D. A. Stevenson and Prof. Piazzi Smyth that I had endeavoured to claim the aseismatic joint of Mr. D. Stevenson was due to their imperfect acquaintance with seismological literature. I certainly intercalated a *note* about aseismatic structures in a report to the British Association on earthquake phenomena in general, without mentioning Mr. Stevenson's name.

Previous to this, when specially speaking or writing upon aseismic structures, I have *repeatedly* referred to the work of Mr. D. Stevenson. Such references were quoted. Under the circumstances I asked Messrs. Stevenson and Smyth to distinctly state whether they still considered themselves justified in continuing their accusations. If this point was overlooked the discussion might be considered as at an end. Mr. D. A. Stevenson has replied, but the question at issue *has been distinctly evaded* (NATURE, vol. xxxiii. p. 534).

I deeply regret that Messrs. Stevenson and Smyth should allow a discussion to terminate in such a manner.

Tokio, May 22 JOHN MILNE

[This must now close.—ED. NATURE.]

Professor Newcomb's Determination of the Velocity of Light

I HASTEN to correct an error which has crept into my account in last week's NATURE (p. 171) of Prof. Newcomb's measures of the velocity of light. The arrangement employed by Foucault in 1862 was *not* that adopted by Newcomb, and illustrated in Fig. 1, but that sketched in Fig. 2. In other words, he placed his lens between the revolving and fixed mirrors. His apparatus is described in *Comptes rendus*, t. lv. p. 792, where the velocity of the rotating mirror is stated to have been 400 revolutions a second, and the total length of path between the mirrors 20 metres. A. M. CLERKE

June 28

Solar Halo and Sun Pillar seen on June 5, 1886

WHEN approaching the Observatory, about 6.45 p.m., my attention was drawn to portions of a solar halo, which appeared as in Fig. 1.

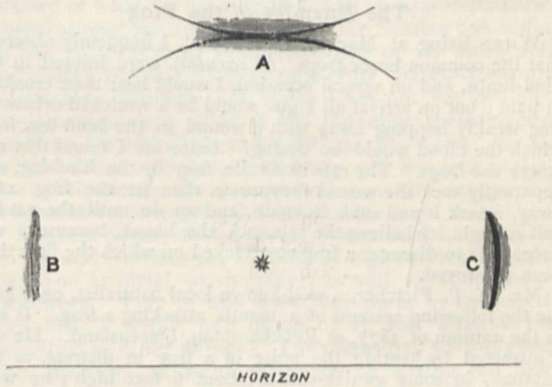


FIG. 1.—A, very bright; C, fainter; B, very faint.

This remained visible until after 7 p.m., and nothing more was seen before 7.30 p.m. When looking out at 7.40 p.m. G.M.T., I noticed something unusual, and came at once to the conclusion that it was a solar pillar, and made a sketch in a note-book and the following remarks:—

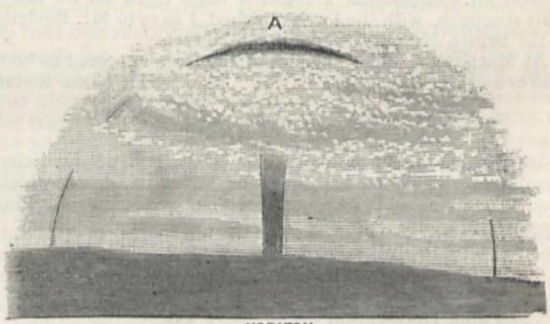


FIG. 2.

The shaded part in the foregoing, other than the halo, pillar, and stratus cloud, represents cirrus.

The pillar apparently rose from the sun, which—when I looked out at 7.40—had just gone below the top of some dark stratus cloud, directly to the upper part of the halo marked A. It was not more than 10° high at the brightest, but quite as much, as I estimated it to reach *nearly* half-way to the portion of the halo A, and the width four times the diameter of the sun. The lower part of the pillar was well defined and of a golden colour; as it approached the halo it gradually became fainter, and was then lost in the cirrus cloud. The upper part was somewhat wider; perhaps this was due to the greater amount of cloud there, which diffused the light.

At 7·55 G.M.T. all portions of the halo had gone except a small piece at A, and the pillar was fainter, but still quite visible. At 8·3 the halo and pillar had disappeared. The sun set at 8·14 p.m.

An ordinary halo (22½°) was visible, more or less bright and complete nearly from sunrise to sunset.

I could not fix the position of the pillar by stars, none near being visible. The sketch was made at the time from a window of the library of the Observatory.

That seen here on 1883 April 6, by Mr. W. A. Robinson, was about 15 minutes *after* sunset; this observation was 30 minutes *before*. The time at which the pillar was visible on the former date was given by nearly all your correspondents as

15 m. to 45 m. *after* sunset, and in most cases in a cloudless sky; but that on 1886 June 5 was the reverse in both points. Some notes will be found in NATURE, 1883, April and May, for the pillar observed in that year. That seen here partly resembles Fig. 4, Plate III. in *Symons's Meteorological Magazine*, 1871. F. A. BELLAMY

Radcliffe Observatory, Oxford, June 21

The Enemies of the Frog

WHEN living at Mackay, Queensland, I frequently observed that the common house-frogs (*H. cœrulea*) were injured in the hind-limbs, and on several occasions I would hear them croaking in pain; but on arrival all I saw would be a wretched exhausted frog weakly hopping away with a wound in the hind-leg, from which the blood would be oozing. Later on I found that rats attack the frogs. The rats catch the frog by the hind-leg, and apparently suck the wound they cause, then let the frog crawl away, attack it and suck it again, and so on until the rat has had enough. I believe the rats suck the blood, because I was never able to discover a frog so attacked on which the flesh had been destroyed.

Mr. W. P. Fletcher, a well-known local naturalist, once gave me the following account of a mantis attacking a frog. It was in the autumn of 1877, at Rockhampton, Queensland. He was "attracted by hearing the noise of a frog in distress, in the daytime, in some garden-shrubs about 6 feet high; he went to see the cause, and found a green frog about 2 inches long. A green mantis about 5 inches long, with one claw had hold of it across the neck, so that the frog could not move, and the mantis was chewing, and did chew off, the hind-leg, the blood flowing profusely." He called Mrs. Fletcher to see them, and then destroyed the mantis, whereon the frog crawled away.

At Lake Elphinstone (100 miles from Mackay) I once found a small frog (*H. rubella*) in the house in a very exhausted condition; on examination I found a large leech on its tongue. This specimen, with the leech attached, I gave to Mr. Boulenger at the British Museum, where it can be seen.

At Mackay the chief enemies of the frogs appeared to be the snakes and the *Agamidæ*. H. LING ROTH

Chronology of Elasticians

IN forming a chronological list of writers on elasticity I have been unable to ascertain the following dates, which I should be much obliged if any of your readers would kindly supply: Mariotte (*né près de Dijon vers* 1620, Marie). Is nothing more definite known as to the date of his birth?

F. E. Neumann	Death years.
W. Weber	Death years.
Eaton Hodgkinson	Death years.
S. Haughton	Birth years.
J. H. Jellett	Birth years.

University College, London, June 27 KARL PEARSON

SOLAR METEOROLOGY[1]

SIG. TACCHINI'S detailed report on the various phases of solar activity during the year 1884 deserves, as might be expected from the reputation of its author, most careful attention. Exceptionally fine weather permitted observations of sunspots and faculæ to be made at the Collegio Romano on 307 out of the 365 days, so that the materials accumulated were more than usually abundant. We are thus particularly well informed regarding the symptoms attending the protracted maximum which culminated in February 1884.

This is the more fortunate as that maximum was distinguished by features of special interest. It was delayed considerably beyond the usual term, the interval from the maximum of 1870 being no less than 13·4 in lieu of the normal 11·1 years. And to this delay corresponded a greatly reduced intensity, in accordance with the law by which the undulations of the curve representing spot-frequency are low in proportion as they are long. The maximum of 1884, accordingly, was by much the feeblest which had occurred since 1830. It was moreover a hesitating—it might almost be called an abortive—maximum. Some unknown cause apparently interfered with its due and punctual development. Partial anticipatory outbreaks betrayed the tendency, continually repressed, to complete the cycle at the regular epoch, and with the regular expenditure of energy. Now perturbation—of whatever nature—is always instructive: hence Signor Tacchini's laborious statistical results acquire added significance.

They have been gathered along several closely connected lines of research. The various classes of solar surface-phenomena—spots, faculæ, prominences, metallic eruptions—have been studied apart, and the several resulting inferences as to the progress of solar disturbance subsequently confronted. The trifling discrepancies thus revealed show the mutual dependence of no two such species of commotion to be absolute. Each swells or subsides on the whole without immediate or invariable reference to any other, although under the obvious control of some common underlying cause.

Sunspot activity received a notable accession in the beginning of October 1883, the phase of excitement reaching its acme in the following February,[1] and persisting until the end of May. Since then, some slight oscillations notwithstanding, it has continually declined. The sun was not, however, observed at Rome to be free from spots on a single day in 1884. The maximum for prominences occured in March, and they continued exceptionally numerous down to the end of October. In all, 2714 were delineated and described in 242 observations with the spectroscope, being at the average rate of 11·22 per diem. Sixty metallic eruptions, observed on the same occasions, gave a mean diurnal frequency of 0·248 as against 0·171 for 1883. The richest crop was collected in November 1884, during which month ten eruptions were recorded in sixteen observations. The development of faculæ deviated so markedly from that of spots that their respective fluctuations were at times even inverted. It should also be noted that the mean area per spot in 1884 was of little more than half its value in the preceding year, and that the magnetic instruments at Rome remained throughout comparatively calm

Much valuable information is afforded by Signor Tacchini's careful inquiries as to the distribution on the sun's surface of the different orders of solar phenomena. All these showed, during 1884, a conspicuous prevalence of activity in the southern hemisphere; and the inequality—as appears from a note by the same author presented to the Reale Accademia dei Lincei, March 7. 1886—became still more striking in the ensuing year. No spot was observed in either hemisphere during 1884 at more than 30° from the equator; nor on the northern side, during the latter half of the year, at above 20°. With this contraction of the spotted zone coincided a close approach to the equator of the parallel of maximum frequency; and the usual equatorial minimum was both in 1884 and 1885 very imperfectly maintained.

Prominences were plentifully distributed between 60° north and 50° south latitude, with maxima between 20° and 30°. As during the spot-maximum of 1870, they showed no disposition to avoid the vicinity of the equator; while in 1880, 1881, and 1882, the equatorial minimum of prominences was very marked, and remained perceptible in 1883. Although some rare instances of metallic eruptions were detected in high northern latitudes, they affected chiefly a zone bounded by parallels of 20°. Faculæ occurred predominantly in the same region, and nowhere appeared in latitudes above 50°. On the whole, a concentration towards the equator of the whole range of phenomena was unmistakable, and might be thought to

[1] "Meteorologia Solare." Note di P. Tacchini. Estratto dagli *Annali della Meteorologia Italiana*, Parte 3, 1884. (Roma: Tipografia Metastasio, 1885.)

[1] M. Rudolf Wolf places the maximum in November 1883.

correspond with a more advanced stage of the spot-cycle than was indicated by numerical data alone.

Signor Tacchini concludes his memoir with a survey of the vicissitudes of spot-formation during eight years—from January 1, 1877, to December 31, 1884. The results are graphically exhibited in a set of curves variously derived. No. 1 is constructed from the daily numbers of spots with their accompanying pores; No. 2 from the record of spots alone; No. 3 shows the frequency of groups; No. 4 follows the fluctuations of spotted area; No. 5 those of facular extension. All the first four methods agree in fixing the absolute minimum in March 1879; Nos 1, 2, and 3 display secondary maxima in September 1880, March and July 1881, and March 1882: the absolute maximum was reached, judging by the statistics of spots and groups (curves 2 and 3) in February 1884; but in November 1883, according to those of spots with pores, and spotted area (curves 1 and 4). It is noticeable that the preliminary maxima are largely exaggerated in proportion to the true maximum, when pores are admitted into the account with spots; while the curve resulting from the simple enumeration of groups is very slightly indented. This last method is regarded by our author as that which should invariably be followed when recent have to be compared with ancient records of sunspots; but no system of observation with the eye can any longer compete with the simpler and surer one of photographic registration.

The curve of facular extension for 1877-84 is somewhat anomalous. It touched its lowest point in November 1878, five months previous to the spot-minimum, then sprang up to an absolute maximum in October 1880. This was followed by a secondary but very considerable rise in September 1881, after which, during two years, a tolerably high average level was maintained. The definitive decline which set in in September 1883 was only partially arrested in May 1884. The coincidence between the maximum of faculæ in September 1880, and a large and abrupt increase in the formation of pores, just a month earlier, should not be overlooked. It is also remarkable that a maximum of prominences, but slightly inferior to that of 1884, occurred in 1881.

The condition of the sun in 1885 is epitomised in the note by Signor Tacchini already referred to. That year was, in his opinion, distinguished as one of continued agitation by the persistent abundance of its various symptoms in the neighbourhood of the equator. A zone of 40° north and south covered all the spots, and (save one example of each kind) all the faculæ and metallic eruptions observed. The tranquil or "hydrogenic" description of prominences, on the other hand, figured indifferently in all latitudes. Their general equality of diffusion was but slightly infringed by a southern preponderance; while the frequency in the same hemisphere of spots, faculæ, and eruptions was, in each class, almost double that of its northern occurrence. The alternating activity of the solar hemispheres, thus exemplified in one of its most conspicuous phases, is one of the many enigmatical features of solar disturbance.

SEISMOLOGY IN JAPAN[1]

FOUNDED only in 1879, the Seismological Society of Japan is already able to point to a good record of accomplished work. The Society was happy in the time and the place of its birth. No home could be more fitted to nurse the enthusiasm of the seismologist than one whose foundations are shaken, on the average, a little oftener than once a week. One may take a rather half-hearted interest in other natural phenomena, but, while it lasts, an earthquake certainly commands undivided attention. And the Society came into being just when a few zealous investigators were striving who should be first to solve the problem of obtaining an accurate record of how the ground moves in an earthquake. Lord Byron has described a thunderstorm in the Alps as the joy of the hills "o'er a young earthquake's birth;" but the joy of the hills, if more loudly expressed, was nothing like so deep as the joy with which the inventor of a new "earthquake machine" felt the first convulsion that came to test its powers. In these congenial conditions it is not surprising that the Society's early volumes record the history of what is nothing less than a new departure in observational seismology. Of late the Society has suffered by the removal from Japan of some of its more active members; but this latest volume of its *Transactions* gives satisfactory evidence that, while it has not yet lost all its foreign supporters, some of the Japanese themselves are ready to step forward and continue the work. So long as Prof. Milne remains, the Society will not lack material for publication; the present volume, like many of its predecessors, is largely the work of his pen.

The first paper, on "Seismic Experiments," is by Mr. Milne, and contains an account of eight series of experiments on artificial earthquakes, as well as some laboratory work. Part of this work was done in conjunction with Mr. T. Gray, and much of it has already been described in other papers. The vibrations of the ground were produced in some instances by letting fall heavy weights, in others by the use of dynamite. Several observing-stations were selected, at various distances from the source of disturbance, and generally in one straight line with it. At these stations seismographs of various kinds were placed, and Prof. Milne seems to have preferred the horizontal pendulum seismograph of the present writer as an instrument for recording separately two rectangular components of the horizontal motion of the ground. By placing the pair of pendulums so that one recorded vibrations in the direction of the line joining the station with the source, while the other recorded vibrations at right angles to this, Prof. Milne was able to separate without difficulty the normal from the transverse constituents of the disturbance, and to see the normal vibrations arrive sooner than the transverse vibrations at each station, as the theory of waves in elastic solids requires. In this instrument the two components of horizontal motion are separately recorded on a moving plate of smoked glass. Another instrument was used to record the whole horizontal movement on a fixed plate, and, as might be expected, the diagrams it gave showed first a movement in the line of the source, quickly followed by a confused wriggle of vibrations in all azimuths. By telegraphically connecting the moving plates of the horizontal pendulum seismographs, Prof. Milne endeavoured to determine the interval of time between the arrival of the disturbance at successive stations, and so to infer the velocity of transit. From the results he has concluded that the velocity decreases as the disturbance travels away from the origin, but the figures on which this conclusion is based seem to the present writer to furnish very insufficient evidence. In one series of experiments there is, in the average of three pairs of observations, a loss of about 6 per cent. in the velocity between the second and third stations as compared with the velocity between the first and second stations; but, when we examine the individual observations, we find in one case a gain of velocity amounting to 14 per cent. And, on turning to what is apparently the most complete series of automatically-recorded diagrams (which are reproduced in lithographed plates), it is clear that the time-intervals cannot have been measured with the precision necessary to establish this result, still less to justify the further conclusion that the velocities of normal and transverse waves become more nearly equal as the disturbance spreads. The velocity of transit is, in fact, a term of very vague meaning, unless we can follow an individual wave along its course. As Mr. Milne's

[1] *Transactions* of the Seismological Society of Japan, vol. viii. (Tokio: Published by the Society, 1885.)

own observations show, the shock loses much of its individuality as it travels further from the source. It becomes more and more preceded by a vanguard of small waves, and, for this reason, seismoscopes of different degrees of sensibility will differ in the time at which they chronicle the arrival of the group. Mr. Milne's results, as summarised by him at the end of the paper, are too numerous to be taken up in detail. The assiduity with which he has pursued these experiments deserves the greatest praise, especially as the experiments themselves are of a very high order of difficulty. It is perhaps to be regretted that Mr. Milne has not given his attention more to perfecting a single series than to multiplying results which, as he himself remarks, are often "most discordant." Seismographs will not tell the truth unless they are very well made and very carefully tended. Some of the jagged outlines of the curves are much more likely to be due to friction and shakiness and want of rigidity in the instruments than to any characteristic in the motion of the ground; and unless the lithographer has done Mr. Milne a serious injustice, there are cases where the ground suffers a considerable displacement in a good deal less than no time. He has himself observed this in one instance, and ascribes it to what must (if his explanation be correct) be called a faulty mode of setting the seismographs. It is not impossible to get results free from these defects; and a single really good set of diagrams would do much to remove the uncertainty which now attaches to many of Mr. Milne's results.

Besides the experiments with artificial earthquakes, the paper describes a laboratory investigation of the stability of cylindrical columns standing on a platform which vibrates horizontally, and of the velocity of projection of detached bodies. The projected bodies were balls, held in L-shaped notches at the top of a vertical wooden post; the post, bent slightly to begin with, was allowed to spring; the velocity of projection of the ball was determined from its trajectory, while the greatest velocity of the post-head was measured by means of a revolving plate of smoked glass. The two agreed fairly well, and with a nearly frictionless ball supported in this manner no other result was to be expected. The late Mr. Mallet used to calculate the velocity of the ground's motion from observation of the horizontal distance traversed by projected bodies, but the velocity with which a body is projected depends too largely on the mode of support, and on the amount of adhesion between the body and the support, to allow the result to be, in general, of the slightest value. With regard to the overthrow of columns, it would seem that the author falls into the error of supposing that when the resultant force got by compounding the weight of the column with its resistance to acceleration passes outside the base, the column will fall. But since the disturbing force is of short duration, all that necessarily happens in such a case is that the column will rock; whether it will fall or not is a question of much greater difficulty.

The second paper is a note by Mr. S. Sekiya, "On Prof. Ewing's Duplex Pendulum Seismometer, with Earthquake Records obtained by it." The paper is a brief but very clearly written account of a form of the duplex pendulum seismograph designed by the present writer in 1883, and now in constant use under Mr. Sekiya's care. An earlier form of the instrument has already been described in NATURE (vol. xxx. p. 152): the latest modification of it was exhibited to the British Association at Aberdeen, and will shortly be illustrated in this journal. Its function is to draw on a fixed plate a magnified diagram of the ground's horizontal motion; the figures, which are generally of great complexity, are given by Mr. Sekiya for a number of recent Japanese earthquakes.

A short paper follows by Mr. E. Knipping, "On the Meteorology of Japan," gathered from observations made at twenty-three stations during the year 1883. It mentions that the annual variation of temperature for that year in Japan was more than double that of Britain, and that changes of 14° C. or 15° C. at one station in twenty-four hours are not unfrequent in the spring and autumn.

A paper by Father Faura, S.J., of Manila, describes the Cecchi seismograph—an instrument belonging so decidedly to the old school of seismology that, by allowing its description to appear without criticism, the Society at least shows its catholicity of spirit.

Dr. Dubois contributes some notes on the earthquakes of Ischia, and refers to the effects—or rather absence of effects—of the earthquakes in excavations there, in support of the fact that seismic shocks which do much damage on the surface may pass unperceived at a certain distance beneath.

The volume concludes with a catalogue of earthquakes registered in the meteorological observatory of Tokio by Palmieri's recording seismoscopes. The list for 1884 shows the respectable total of seventy distinct disturbances, and twenty-eight were registered in the first four months of 1885.

J. A. EWING

RECENT ADVANCES IN SANITARY SCIENCE

"HYGIENE," in the words of the late Professor Parkes, "is the art of preserving health; that is, of obtaining the most perfect action of body and mind during as long a period as is consistent with the laws of life. In other words, it aims at rendering growth more perfect, decay less rapid, life more vigorous, death more remote." The art of preserving health is correlative with the science of prevention of disease, since perfect health means the absence of disease and of tendencies to disease. Hygiene is thus the art of preserving health and the science of preventing disease; and in taking into account recent advances in sanitary science we must consider recent acquisitions in our knowledge of the origin, causes, and spread of disease, more especially of those diseases known as "preventable," as well as the methods of improving the natural conditions or social relations surrounding us, which are instrumental in preserving health and counteracting disease.

The etiological relations of all diseases are a subject of interest to the sanitarian, but those which have received the most attention of recent years, and in which the most striking advances of knowledge have either already been made, or are imminent in the near future, are perhaps Asiatic cholera, typhoid or enteric fever, diphtheria, and phthisis or tubercular disease of the lungs. The mode of origin and spread of Asiatic cholera has attracted great popular attention, both on account of its possible introduction into this country from infected districts of the Continent, and from the alleged discovery by Koch of a *Spirillum* or *comma-Bacillus* asserted to be the specific cause of this terrible disease. The Report of the Government Commission consisting of Drs. Klein and Heneage Gibbes, who visited India in 1884 with the object of undertaking researches into the etiology of Asiatic cholera, has lately appeared, and in this Report the conclusions arrived at by Koch from his own researches are very directly traversed. This Report, too, has received a very cordial support from a Committee consisting of many eminent physicians and physiologists, which was convened by the Secretary of State for India for the purpose of taking it into consideration. It must be apparent, however, to any one who makes an impartial study of the literature of the subject, that, if Koch's organism has not yet been proved to be the actual cause of the disease, it has been proved to differ from all other organisms asserted to be identical with it, from the fact that its growth in various nutrient media is characteristic, and serves to distinguish it from all other organisms. As far as our knowledge at present extends, difference in manner of growth in nutrient media affords as just a basis for distinction between micro-organisms as difference in microscopical appearance or other morphological characteristics. Koch's comma-Bacillus is therefore diagnostic of the disease, and this fact has now placed in the hands of medical men the power of at once recognising a true case of Asiatic cholera, the isolation of the organism from others in the choleraic discharges and its cultivation in suitable media being alone needed. The results of Koch's researches, whether fully accepted or not, have not affected, nor are they likely to affect, the measures on which reliance alone can be placed for the prevention of outbreaks and spread of the disease. In the words of the Committee before alluded to, "Sanitary measures in their true sense, and sanitary measures alone, are the only trustworthy means to prevent outbreaks of the disease, and to restrain its spread and mitigate its severity when it is prevalent. Experience in Europe and in the East has shown that sanitary cordons and quarantine restrictions (under whatsoever form) are not only useless as means for arresting the progress of cholera, but positively injurious."

The view that typhoid fever cannot arise *de novo*, but is always propagated by a specific contagion from a previous case of the disease, is steadily gaining ground, as the number of epidemics where the disease has been definitely traced to specifically polluted air or water increases. In many other cases, although the specific pollution has not been definitely proved, the probabilities in favour of such a view have been very great. No micro-organism has yet been found which can lay claim to be regarded as the specific contagion of the disease, but we are in possession of so many facts concerning the mode of origin and spread of this disease, that any discovery of that nature would probably not greatly affect the measures now taken for its prevention.

The etiology of diphtheria has lately received very careful study, but so far without the attainment of any results capable of exact formulation. It is not a disease invariably dependent on insanitary conditions, such as typhoid fever is, but that such conditions favour its spread and severity is more than probable. The far greater comparative frequency of diphtheria in rural districts than in large towns in this country is well known, and has been attributed to the presence in the air of the latter of the products of coal combustion. This view appears the more probable seeing that Continental cities, where wood and not coal is chiefly used as fuel, enjoy no such comparative immunity from the disease. Excessive moisture in the air of a house, whether arising from defective construction of the walls or roof, or from a water-logged soil, are conditions very often associated with diphtheria. The fact also that the disease is most prevalent in the damper seasons of the year, when vegetable matter is undergoing decay and fungus life is most active, favours the theory that the specific contagium of this disease is a mould or fungus, which flourishes most strongly in a damp and smokeless air. It is a remarkable fact that diphtheria is sometimes associated with scarlet fever in one epidemic, the two diseases appearing to be interchangeable; but this is a subject that requires further elucidation. The contagion of diphtheria is extremely persistent and long-lived, clinging with great pertinacity to infected articles, so that every article which is likely to have become contaminated requires very thorough disinfection, preferably by heat. There can be no doubt that school attendance is often a chief factor in the propagation of the disease amongst children.

Koch's discovery of the *Bacillus tuberculosis*, a micro-organism now proved to be the specific contagium of tubercular disease in men and animals, has placed tubercular phthisis in the category of contagious diseases. A peculiar disposition or tendency, whether hereditary or acquired, is no doubt wanted to enable the germ to take up its habitat in the human lung, but the fact that this idiosyncrasy can seldom be definitely recognised renders great caution necessary both on the part of members of a family in their association with a consumptive relation, and of hospital authorities in admitting into a general ward cases of tubercular disease, or of massing together into one institution patients in every stage of the disease. The Bacillus is constantly present in the sputum and probably in the breath of phthisical patients, and this points to the necessity of free ventilation of living and sleeping apartments, and disinfection of soiled articles of clothing and furniture. The external conditions which, of all others, cause a predisposition to consumption are, a damp subsoil, causing excess of moisture in the air, and the constant breathing of an atmosphere vitiated by human respiration. It has been asserted that tubercle can be propagated from animals to man by the consumption of diseased meat, or, in the case of the cow, from the milk of a tuberculous animal. Further proof is required before we can accept such an hypothesis, but there is nothing improbable in such a mode of conveyance of the disease, especially in the case of children with a tubercular predisposition.

Besides the diseases which we now know to have been propagated through the agency of milk—enteric fever, scarlet fever, diphtheria, &c., in which the introduction of the morbid matter is accidental, the milk serving only as a means for its conveyance and perhaps for its growth—there is a complaint fairly definite in character, which has been attributed to the consumption of the milk of cows suffering from foot-and-mouth disease. Here the morbid quality is inherent to the milk as taken from the cow, and is not due to an accidental introduction. The symptoms described in the epidemics recorded are fever, vesicular eruptions on the lips and in the throat and mouth, and enlargement of the glands of the neck. During the prevalence of foot-and-mouth disease, all milk taken by a household should be boiled before consumption. In view of the many dangers which threaten us through the agency of milk, it would perhaps be advisable, especially where children are the chief consumers, that this precaution should be always adopted; at least until the sanitary authorities in towns have the power of inspecting and controlling the farms and dairies in the country from which the chief part of the milk-supply is derived.

The possibility of the transmission of the contagion of small-pox for considerable distances, not exceeding one mile, through the air, has been warmly supported. There are many facts in favour of such a view, and its great probability will be seen from the following considerations. The contagion is almost undoubtedly a micro-organism of the class Bacteria, but as it has not yet been isolated and identified, we are unaware if it is capable of spore-formation or not. The spores of Bacteria can resist external agencies—heat, cold, drying, and antiseptics—to a much greater extent than the fully formed organisms, and it is probable that those diseases in which the contagion remains dormant for long periods are transmitted through spores capable of existing for long periods outside the body. But in small-pox it is not necessary to rely upon spore-formation to support theories of aërial transmission. The contagion as given off from the body of the patient is inclosed in minute epithelial scales and dry pus accumulations. Here, protected from the air and from external destructive agencies, it may be wafted as a minute dust through the air, to descend at considerable distances. That the radius of infection from a small-pox hospital as a centre does not exceed a mile may be due to the great dilution of the contagion as it is diffused through greater distances than a mile from its centre of origin, the hospital. The observations of Dr. Miquel, at the observatory of Montsouris near Paris, have shown the number and variety of solid particles which are carried in the air, and the immense distances which some of them, as pollen and spores, may be presumed to have travelled. An educated public opinion will soon, if it does not already, regard small-pox hospitals as possible centres of infection, and will insist on their removal outside inhabited areas.

The compulsory notification of infectious diseases to sanitary authorities, either by the householder in whose house the case occurs, or by the medical attendant, or by both, has been adopted in numerous provincial towns during the last five years. This measure has done much to furnish the authorities with early information of the occurrence of infectious disease which would not otherwise have been obtained, and such information has doubtless enabled the sanitary officials to stamp out many an epidemic in the bud, which might otherwise have reached large dimensions. The more universal adoption of a measure of compulsory notification in our large towns is urgently needed.

In the domain of domestic sanitation the advances of recent years have been mostly limited to the practical applications of sound principles already acquired to the carrying out of works of construction, drainage, or water-supply of the dwelling. Houses built for the use of the well-to-do classes (not those of the speculative builder) in recent years will most generally be found to be planned and fitted on modern sanitary principles. Thorough ventilation of the drain and soil-pipe, disconnection of the waste-pipes of baths, sinks, and lavatories, and of the overflow-pipes of cisterns from the drainage system, are now understood to be necessaries of modern life. A break in the connection between the house-drain and the public sewer by means of a manhole chamber and water-seal or trap, though not considered necessary or desirable by all, is now very usually practised. We cannot doubt that the air of a public sewer is sometimes the means of disseminating disease, and any method which practically excludes such a source of danger from our houses is one to be encouraged. As knowledge extends, the simplest form of apparatus is found to be the best; many of the more complicated kinds of traps and contrivances for excluding sewer air are now discarded by builders and architects for those simpler forms which are equally effective.

In the matter of water-supply, the belief is steadily gaining ground that a water once polluted by sewage cannot be regarded as safe for drinking purposes. Safe it may be so long as filtration on the large scale is efficiently performed, but any failure to thoroughly filtrate and aërate the water in times of epidemic visitation might be attended with disastrous consequences, even supposing that filtration through sand and gravel is destructive of disease organisms or their spores. The introduction of a constant supply of water into towns, in the sense that cisterns and receptacles for storing water are no longer necessary, has been of great benefit—especially in the poorer parts of towns, where water stored on the premises is usually highly contaminated.

Of the scientific witnesses who were examined before the Royal Commission on Metropolitan Sewage Discharge, nearly all were in favour of the principle of separation of the rainfall from the sewage. "The rain to the river, the sewage to the soil." In view of the ultimate disposal of the sewage, the advantages of the "separate method" are very great, and would now probably lead to its adoption in any new scheme of sewerage for a town where the circumstances are favourable. From the public health point of view, it is also desirable to have impermeable pipe or brick sewers of small size, so that contamination of the soil by leakage into it of the contents of sewers may be avoided. In any such scheme of sewerage it must not be forgotten that not only are channels on the surfaces of the streets and roads required to convey away surface water, but pervious drains laid in the subsoil are absolutely necessary in the health interests of the town to keep the subsoil water at a permanently low level. For the disposal of the sewage, the value of a regular daily flow, and the elimination of the necessity in times of heavy rain of dealing with an enormous and uncontrollable volume of dilute sewage, must be obvious. The surface waters of towns are certainly not clean, but where the streets are efficiently scavenged they are free from taint of human excretal refuse, and fit for admission into the rivers which nature intended as drainage channels of the surrounding high lands.

The extreme importance of thoroughly ventilating sewers, is now very generally understood. Pipe sewers require as much ventilation as brick sewers, although the absence of deposit on the smooth internal surfaces of the pipes, and their consequent freedom from smell due to decomposition of deposited organic detritus, originally led to the belief that ventilating openings were not required in pipe systems of sewerage. It was not until Dr. Buchanan showed in the case of Croydon that the absence of proper ventilation in the pipe sewers of that town was in all probability instrumental in aiding the spread of enteric fever that the opinion of engineers on this matter underwent a change. Displacement of air in pipe sewers of small diameter is greatly more sudden than in brick sewers of larger diameter, and it is plain, says Dr. Buchanan, that "means of such ventilation are wanted more numerously in proportion as the displacements of air may be local and sudden." Openings into sewers from the street level are still regarded as the best practicable means for the admission of fresh air, and the exit of sewer air. Charcoal trays, Archimedean screws, and other contrivances for purifying the issuing air, or hastening its exit, are now generally abandoned as useless and inconvenient.

The purification and utilisation of the sewage of towns is a subject of much importance both in its public health and commercial aspects. The idea, so long entertained, that town sewage could by various methods be made to yield a manure which would give rise by its sale to an enormous profit is now exploded. The highest degree of purification, we now know, can only be attained on land naturally suitable from its porosity and other properties, and artificially prepared by extensive under-drainage. The agents which purify sewage in its passage through soil, by converting the nitrogenised organic matters into inorganic salts—nitrates and nitrites of the alkaline and earthy bases, and ammonia—have been discovered to be Bacterial micro-organisms, resident chiefly in the superficial 18 inches of soil, and far more abundant in some soils than in others. Sewage farming has been ascertained to be profitable, under suitable conditions. The sewage must flow from the town to the farm by gravitation—the cost of pumping will neutralise profits from the sale of farm produce; a part of the farm must be laid out as a filter bed, so that the sewage, when not required on the cultivated land or when so dilute from the presence of storm waters as to be inapplicable, may be purified on a small very porous area by the process of intermittent downward filtration. Very few growing crops are benefited by the application of sewage, except the various kinds of grasses, and of these such enormous quantities can be produced that, unless converted into "silage," or utilised on the farm in the production of stock and dairy produce, they may be expected to result in a loss, from the absence of any demand for such large quantities at all periods of the year.

In this country, the sewage farm at Birmingham is probably the best example of what has been done to solve a most difficult problem by the application of sewage to land. Here, the sewage is first freed from its suspended matters by a process of precipitation, a proceeding necessary not only to prevent warping of the land with offensive solid matters, but also to withdraw the metallic salts and acids incidental to the sewage of a manufacturing town, which would be injurious to vegetation. Even this magnificent example of dealing satisfactorily with the most difficult municipal problem of modern times is eclipsed by the city of Berlin on the Continent. The sewage farms at Berlin have successfully dealt with the sewage of 387,500 people—nearly twice the population of Birmingham—whilst London is still allowing to run to waste an enormous amount of valuable material, at the same time polluting a river—the highway of its commerce—to an extent never previously dreamt of.

Processes of precipitating sewage by chemicals are now known to exert only a partially purifying influence. The best process yet discovered can do little more than free the sewage from its suspended matters, allowing all the dissolved constituents of sewage—by far the most valuable portion agriculturally and chemically—to pass away in the effluent. Lime dissolved as lime water, sulphate of alumina, and perhaps proto-sulphate of iron, taken together and added to the sewage in the proportion of not more than 10 to 15 grains to the gallon, are the best, most economical, and most effective precipitants. Other more valuable substances, added to the sewage with the view of increasing the value of the precipitated sludge or manure, are in large proportion lost in the effluent water, and as they do not assist precipitation might just as well be added to the sludge afterwards, if fortification is required. Half-a-crown and no more is the value per ton of the precipitated solids of sewage. This value will generally pay for the cost of their carriage a mile or so in agricultural districts, but no further.

A great improvement in dealing with the semi-liquid sewage sludge has been lately effected. The sludge containing over 90 per cent. of water was formerly allowed to dry in the air or in a drying chamber, and a most intolerable nuisance resulted. It is now possible by means of hydraulic filter-presses to convert the semi-liquid sludge into solid cakes containing 40 to 50 per cent. of water, and in this form it is innocuous to the senses, and can be readily conveyed away by cartage.

The knowledge already acquired demands that now, and in the future, the sewage of towns should, whenever possible, be utilised on land in the production of crops or dairy produce; failing this, the sewage should be freed from its solids by precipitation, and subsequently purified on land laid out as filter-beds, efficient purification, and not the production of crops, being alone aimed at. If application to land is impossible, then precipitating processes alone must be relied on, and where the sewage can be turned into the sea, and effectually got rid of without nuisance, there it may be allowable to waste valuable matter which cannot be utilised except at a cost destructive of all profits from its utilisation.

SALE OF THE JARDINE ORNITHOLOGICAL COLLECTION

THE dispersal of an ornithological collection so large, and of such historic interest, as that formed by the late Sir William Jardine, F.R.S., is an event deserving of notice. The collection was begun more than sixty years since, and was the occupation of half a century's diligent care. From its contents were described, and often figured, a majority of the species treated of in the late baronet's many works, ranging from the "Illustrations of Ornithology," commenced in 1825, to papers in journals of comparatively recent date, and it included a greater number of "type-specimens" than any other that has ever been brought to the hammer.

On Sir William's death in November 1874, it was understood that the collection would be speedily sold, and a strong hope was entertained by ornithologists that it should pass, *as a whole*, into one or other of the great museums of this country. However, this was not to be. The comparatively small "British" portion was, after a time, purchased by the Museum of Science and Art in Edinburgh, a very fitting destination for it; but the rest, consisting of between 8000 and 9000 specimens, remained in the hands of Sir William's heir. At last that gentleman determined to dispose of it by auction, and for that purpose selected Messrs. Puttick and Simpson, the well-known firm of Leicester Square, by whom it was accordingly sold on Thursday, June 17 last. However, the attendance at the sale was but small, and except in a very few instances, the prices obtained were below the average often reached at sales of collections in every way inferior in interest, while not one of the lots attained a price that may be called high. There was a certain competition among a few experts, but even this was not carried to any excess, and as a rule the prizes of the collection were knocked down for very small sums. It is a satisfaction to read, however, that most of the "type specimens" were secured for the British Museum or for that of the University of Cambridge; but few, it is believed, falling into the hands of dealers, and hardly any, as was to be greatly feared, into those of the "plume-trade." The low prices realised were due, no doubt, to the fact that notice of the sale had reached few amateur collectors in time, and added to this was the fact, obvious on inspection, that the sale catalogue supplied very little of the information which collectors require. It was the general impression in the auction-room at the time, and has since been confirmed by the opinion of practical ornithologists, that had the catalogue set forth the special quality of the specimens, and the sale been made known more widely, a very different result would have followed, and something like the competition which attended the great sale of Mr. Bullock's museum in 1819 might have been attained, for collectors are as keen now as ever, and such a chance as this is not likely to occur again to the present generation. The long period, too, which has elapsed since Sir William Jardine's death (recorded in NATURE, vol. xi. p. 74) possibly helped also to divest the sale of his collection from a good deal of the interest which it would have inspired had its dispersal taken place soon after his decease, for memories are short in these days. The agent of the British Museum has to be congratulated for his promptness in recognising and securing at a nominal price for that institution one "type-specimen" (that of Bulwer's petrel), which, not being mentioned in the catalogue nor occurring in its expected place among the other specimens of its family, had escaped the notice of all the other ornithologists who had viewed the collection.

NOTES

AMONG the Colonials on whom honours have been conferred are Dr. Julius Von Haast, F.R.S., who has been made K.C.M.G., and Dr. A. R. C. Selwyn, who has been made C.M.G.; Dr. G. Watt, of the Indian Department of Revenue and Agriculture has been made a C.I.E.

PROF. PAUL WAGNER, on behalf of the Comité Salitero, sends us the following statement as to the result of the nitrate of soda competition. Carrying out the scheme of prizes offered by the Committee of the Saltpetre Producers' Association (Comité Salitero at Iquique, Chili) for the best popular essay treating of the importance of nitrate of soda as a manure, and the best mode of its application, the judges—Prof. L. Grandeau, Nancy (France); Prof. Adolf. Mayer, Wageningen (Holland); Prof. A. Petermann, Gembloux (Belgium); Prof. G. Thoms, Riga (Russia); Prof. Paul Wagner, Darmstadt (Germany); Mr. R. Warington, Rothamsted (England)—have examined the essays sent in, namely, thirteen German, thirteen English, and four French, and have made the following awards:—(1) To the essay with the motto, "Grau, theurer Freund, is alle Theorie," a partial prize of 350*l*. (7000 marks); (2) to the essay with the motto, "Pour pratiquer l'agriculture . . . ." a partial prize of 150*l*. (3000 marks). On opening the accompanying envelopes, the author of the first essay was found to be Dr. A. Stutzer.

Principal of the Agricultural Experimental Station at Bonn; and the author of the second essay, M. A. Damseaux, Professor in the Agricultural Academy at Gembloux. It should be remembered that essays competing for the second part of the prize offered—namely, 500*l.* for the best essay treating of the same subject, on the basis of *new, personal, experimental investigations*—must be sent to one of the above-named judges, on or before January 1, 1887.

THE Local Committee for the Birmingham meeting of the British Association have their arrangements well forward. A considerable contingent of Canadian and other colonial men of science will no doubt be present, and every effort will be made to extend a hospitable welcome to them and to all the members of the Association who may be able to visit Birmingham. The Great Western, the London and North-Western, and the Midland Railway Companies offer exceptional facilities to intending visitors. The Council of the Birmingham and Midland Institute have placed their spacious lecture theatre, with its convenient suite of rooms attached, at the disposal of the Local Committee as a reception-room, officers' and ladies' rooms, &c. The meetings of the Sections will be held in the Council House, the Mason Science College, the Medical Institute, the Birmingham Municipal School of Art, and in the offices of the Board of Guardians—buildings which closely adjoin each other; and the use of rooms in the Council House has also been granted by the Mayor for other purposes. The Town Hall will be utilised for the evening meetings. Various clubs and scientific and literary institutions will be thrown open to members and associates by the courteous invitation of the governing bodies, and the Committee of the Birmingham Botanical and Horticultural Society will open their Gardens during the week of the meeting to members and associates. The Committee are also preparing an extensive exhibition of the products of local industries and of local manufacturing processes, which will be held in Bingley Hall. A collection of the flora and fauna, together with the rocks and fossils of the district, will be shown in connection with this exhibition. The Committee are arranging a series of excursions to various localities of great beauty and interest, and many kind offers of hospitality have been received in connection with the projected excursions. The Committee are engaged in the preparation of a guide-book of the town, which will include an account of its history and antiquities, trade and manufactures, a description of its modern government, papers on the geology and physiography (accompanied by a geological map), and the zoology and botany of the district.

SOME of the friends of the late Dr. Walter Flight are anxious to collect a fund to be invested for the benefit of his widow and children, who have been left with extremely inadequate provision. A Committee has been formed with the Rev. Prof. Bonney, F.R.S., as chairman, to carry out this object. The honorary treasurer is Mr. L. Fletcher, Natural History Museum, Cromwell Road, S.W., and the honorary secretaries T. W. Carmalt Jones, M.D., 6, Westbourne Street, Hyde Park, W., and John M. Thomson, King's College, Strand, W.C. Contributions may be paid to the account of the "Flight Memorial Fund" with Messrs. Robarts, Lubbock, and Co., to the honorary treasurer, or either of the honorary secretaries. We need not say a word to impress upon our readers how deserving is such a case as this.

A MOVEMENT is on foot for obtaining subscriptions to purchase an annuity for Mr. J. B. Dancer, who has done so much for the improvement of photography. But photography is only one of the many arts and sciences indebted to him. There is the stereoscopic camera with twin lenses, which he was the first to make. He invented microscopic photographs, which so much delighted and astonished us twenty-five or thirty years ago. He also introduced photography to the magic lantern, being the first to show a photographic transparency on a screen. The lantern itself is also indebted to him, not only in its optical parts and in its construction generally, but also particularly in the application of the oxy-hydrogen light, and for a dissolving gas tap, which saves half the gases and produces the best dissolving effect. Then there should be mentioned, as of much greater importance than the above, the automatic "contact-breaker," used probably by the million at this moment, in every induction coil in the world. Prior to Mr. Dancer's invention, contact used to be made and unmade by hand, in a vessel containing mercury. The first helical coil with the vibrating interrupter was constructed by Mr. Dancer, and was exhibited long after by him at one of the *soirées* of the British Association, when the meeting was held in Manchester. When Mr. Dancer established himself as an optician in Manchester, his presence soon made itself felt amongst the few microscopists then living in the district. Good microscopes were then costly, and worthless ones very common. Mr. Dancer successively brought out several forms of instruments, as excellent in their mechanical and optical arrangements as they were moderate in price. It is sad to have to say that, notwithstanding Mr. Dancer's talents and achievements, he is now living in very straitened circumstances, is morever afflicted with almost total blindness, and therefore unable to follow the optical business to which his life has been devoted. It is not an unusual thing for a man of great mechanical ingenuity and skill to be an indifferent man of the world, and so it has been with him; as a business man he has been a failure. He has made improvement after improvement, invention after invention, any one of which might in "pushing" hands have made a fortune; but, more interested in science than in money-making, he has allowed the golden chances to become public property, and has thus remained poor himself, while the world has reaped the advantage of his labours. Mr. Dancer is now in his seventy-fourth year, and, it is to be hoped that in his hour of darkness the world will pay back to him something for that which it has freely received at his hands. A Committee has been formed for the purpose of receiving subscriptions, and we commend the movement strongly to the support of our readers. The Committee are: J. P. Joule, LL.D., F.R.S., Sale; Prof. W. C. Williamson, LL.D., F.R.S., Owens College; Prof. Balfour Stewart, LL.D., F.R.S., Owens College; John Dale, F.C.S., Cornbrook, Manchester; Leo H. Grindon, Manchester; S. Platt, J.P., Oldham; Charles Bailey, Hon. Treasurer Manchester Literary and Philosophical Society; James Birchall, Hon. Sec. Liverpool Literary and Philosophical Society; Abel Heywood, jun., Higher Broughton (Hon. Sec. *pro tem.*).

DR. ULLMANN, of Vienna University, who spent several weeks with Dr. Pasteur in Paris, and brought back some of the virus with him, began on Monday, in the presence of several eminent professors, to inoculate against hydrophobia. He had for patients thirteen men bitten by rabid dogs and one woman bitten by a rabid pig.

WE regret to announce the death, on the 23rd ult., at his residence, Glenoir, Galway, of William King, D.Sc., Emeritus Professor of Geology, Mineralogy, and Natural History in the Queen's College, Galway, in his seventy-eighth year. Upon the foundation of the Queen's Colleges in Ireland, in 1849, Dr. King was selected to fill the Chair of Geology in the Galway College, a post that he occupied, and of which he fulfilled the duties most assiduously and laboriously, until 1883. In that year, owing to a severe attack of paralysis, Dr. King was most reluctantly obliged to relinquish his professorial duties. In 1882 the additional performance of the business of the Natural History Chair devolved upon him: the double task proved too onerous. Subsequent to his resignation, the Corporate Body of the College presented Dr. King with an address, as a testimony of their esteem for his devoted services, of which latter the Geological Museum in the College is a lasting record. Numerous volumes and also pamphlets upon various branches of geology bear witness to his attainments and indefatigable zeal.

FROM the report just issued by the Swedish Academy of Sciences we gather some interesting particulars of the scientific work prosecuted under the auspices of this Institution last year. On the recommendation of the Academy the following sums were granted by the Government towards scientific research, &c. :—A sum of 150*l.* to the Academy's Zoological Station in the province of Bohus; 200*l.* to Prof. H. Gyldén for the development of his theory respecting the movements of the larger planets; 250*l.* towards the publication of the *Acta Mathematica;* 300*l.* towards the purchase of a zoological and ethnographical collection of objects brought by Dr. C. Bovallius from the West Indies and Central America; 60*l.* towards Prof. Liljeborg's work, "Scandinavian Fishes"; and two sums of 50*l.* each towards Herr Westerlund's work, "Fauna der in der paläarctischen Region lebende Binnenconchylien," and Dr. Lindeberg's exsiccate work on the Rubi of Scandinavia. In addition to these sums, various smaller amounts were granted by the Academy to a number of gentlemen towards scientific researches, as, for instance, for the study of certain algæ on the coast of Bohus, for the study of the Scanian moss flora, for the study of the anatomy and histology of the marine Annelidæ in the same province, and that of the Gasteropoda, &c. Of other scientific work continued last year may be mentioned the work on the great publication recording the scientific of the expedition to Spitzbergen, 1882–83, of which the researches on the aurora borealis and the electricity of the air are now in the press, and the rest, on other branches of science, will shortly follow; and further, the arrangements of the valuable collection for the State Museum of ethnographical objects from all parts of the world—some 6000 in number—made by Dr. Stolpe during the voyage of the corvette *Vanadis* round the world. The Academy also purchased a large estate near Stockholm with the funds bequeathed by Prof. Bergius for the establishment of a horticultural garden, similar to that of Kew, to be under the supervision of the Academy. An important change has been decided on with reference to the publishing of the Academy's *Journal*, viz. to divide it into two parts—Proceedings and Appendix—the former to be issued monthly, containing reports of meetings and short papers and the latter to be issued at intervals, containing longer and more scientific papers; and these will be divided into four sections, each embracing a certain branch of science, which will enable a specialist to find at once the paper desired, and not necessitate the purchase of the whole yearly series.

AN Australasian Meteorological Society has been formed at Adelaide, South Australia.

ON Edison's system of telegraphing with trains in motion, the *Scientific American* (February 20, 1886) says :—The receiving apparatus at both the car end and the fixed end of the line is a telephone. The sending apparatus is also similar at both ends, and consists of an interrupter or vibrating tongue driven by an independent battery, and making 500 vibrations per minute; this vibrator is in circuit with the line battery, an ordinary Morse key, and the primary of an induction coil. The secondary of the induction coil on the car is in connection with the tin covering the entire roof of one or more cars; the secondary coil at the fixed station is in connection either with condensers or with other induction coils, which in turn are in connection with the ordinary line wires by the side of the track. Suppose a message to be sent from the fixed station to the car. The vibrator is always working, but till the Morse key is put down no current passes. The message is sent by the ordinary Morse signal, only instead of a continuous current being sent to line each time, it is an alternating one; this induces a current in the secondary coil, and through it the condensers, for example, are charged alternately. The charge of the condensers is propagated through the line wires with which they are in connection, and influences the tin roof of the car, and ultimately the telephone by which the signals are read.

MR. BLANFORD, Meteorological Reporter to the Government of India, has issued a memorandum on the Himalayan snowfall in the past season. A few years ago, it will be remembered, Mr. Blanford propounded a theory of a connection between this snowfall and the monsoon, to the effect that the later and heavier the snowfall in winter and spring the later and feebler would be the following monsoon. The forecasts based on this theory were fairly accurate last year, and accordingly his forecast this year was looked forward to with anxiety on account of the great value of early and copious rain to Indian agriculture. This year Mr. Blanford arrives at the conclusion that, although a considerable amount of snow fell in the North-Western Himalayas and the hills of Eastern Afghanistan, during the winter and spring, especially in January and February, there has been on the whole less than in the previous year. The snow range, as seen from Simla, is less thickly covered than it was in 1885, and the snow is at a higher level. The winds have been less northerly than usual on the west coast, and more decidedly southerly and easterly in the Punjaub. Hence he thinks that there will be no retardation of the monsoon on the Bombay side; and the barometric levels are favourable to an advance of the easterly branch of the monsoon, so that no apprehension need be felt about the rains in Upper India.

AT the meeting of the Royal Society of Tasmania on April 13, the Curator of the Museum stated that during the past month Mr. Vimpany had captured a black snake (*Hoplocephalus curtus*) at Longley, measuring about 4 feet 3 inches in length. On opening it the unprecedented number of 109 young ones were found in her. The specimens now before the meeting are the largest ones, the measurement being from 8½ inches to ¾ of an inch in length. Mr. Morton stated that the greatest number he had known previously to be taken from a similar snake was 32, but he had been informed by a resident of Tasmania that over 70 had been taken from a similar species.

IN the *Stonyhurst Magazine* for May 1886, is a list of the flora of the Stonyhurst district. It contains a list of all plants of whose occurrence within a radius of ten miles from Stonyhurst satisfactory record can be found.

FROM a communication by M. Nikolsky to the St. Petersburg Society of Naturalists (vol. xvi. 2), it appears that the drying up of Lake Balkhash is going on at a very rapid rate, and so far as the observations of the inhabitants may be relied upon, its level is lowered by no less than two feet every ten years. The maps of 1852 show that a very great reduction of the surface of the lake has taken place during the last thirty years. As to the fauna of Lake Balkhash M. Nikolsky makes the following interesting remarks. It does not include a single species of those fishes which are characteristic of the Aral-Caspian ichthyological region. On the other hand, there is a very great resemblance between the fishes of Lake Balkhash and the lakes on the high plateau of Central Asia, for instance, of Lob-nor. Three species are common to the Ili River and the Tarim, tributary of Lob-nor. M. Nikolsky concludes from the ichthyological data that there is no ground to admit of any direct connection between Lake Balkhash and Lake Aral. If there ever was a sea which covered the Siberian lowlands as well as the depressions of Lake Balkhash and the Aral-Caspian, the Balkhash was separated from the latter at a period when the connection between the Aral-Caspian depression and the Arctic Ocean still existed. There was certainly, in recent geological time, a connection between the rivers of the Balkhash basin and those of the Lobnor basin, which connection probably followed the Kunges, the Yulduz, and the Tarim Rivers.

THE total area of the Crown forests of Sweden at the beginning of 1885 was 5,785,535 hectares, being a seventh part of the total forest area of the country. The revenue from the same was a little less in 1885 than in 1884, but this is believed to be only incidental, it having risen from 750,000*l.* in 1880 to 890,000*l.* in 1882, and 1,120,000*l.* in 1884.

WE have received part 2, vol. iv. of the *Transactions* of the Norfolk and Norwich Naturalists' Society, containing the papers selected for publication and the address read by the President, Major Feilden, F.G.S., at the seventeenth annual meeting of the Society. From the report it appears that the Society now numbers 260 members, and is both numerically and financially in a very satisfactory condition. For his address Major Feilden chose the fascinating problem of the origin of life, which he strove to show must have had its advent at the poles of the earth, a subject which his study of the fossil and recent fauna of the polar regions as naturalist to the Arctic Expedition of 1875–76 gave him special opportunities of studying. The conclusions to which Major Feilden arrives are that through the secular cooling of our planet the poles became first fitted for the reception of life; that in palæozoic times the North Pole possessed a climate as warm, at least, as that now enjoyed at the equator; that the temperature at the North Pole during the Miocene period, though gradually cooling, supported a flora which spread southwards; and that in all probability animal life likewise originated at the poles, and spread towards the equator. Amongst the published papers, one by Mr. Clement Reid, F.G.S., on the "Flora of the Cromer Forest Bed," is of especial interest. Mr. Reid enumerates sixty species of plants, which he has obtained by the careful washing of clays from various localities near Cromer, and calls attention to the curious fact that all these, with the exception of *Trapa natans*, three firs, and *Isoetes lacustris*, are still indigenous to the county of Norfolk, and two-thirds of them are aquatic or marsh plants, identical in species with those found at the present day in almost all the Norfolk morasses. Mr. Edward Bidwell contributes an account of a visit to the Isles of Scilly in the nesting season of 1885; the Rev. H. A. Macpherson a paper on the habits and plumage of the Manx shearwater; Mr. G. Smith some notes on the habits of the Fulmar petrel; meteorological notes by Mr. A. W. Preston; notes on the herring fishery of 1885, by Mr. South. well; a second paper, by Mr. Reid, on Norfolk amber; and a list of the birds of Norfolk, with remarks, by Messrs. Godney and Southwell; also a valuable paper on the gradual assumption of the adult plumage in the honey buzzard, by Mr. J. H. Godney.

WE have received a "Liste Alphabétique" of the Correspondence of Christian Huygens, which the Dutch Society of Sciences proposes to publish. The list may be obtained from Enschedé and Son, Haarlem.

DR. G. F. MARTINEAU, of Yorke House, Stourport, writes with reference to the article "On the Origin of our Potato," in NATURE of May 6 last, p. 7, that in turning over, the other day, the leaves of the sumptuous "Hortus Eystertensis" of Basil Besler, printed in Nuremberg in 1613, he found an excellent plate of the plant (of which he sends a tracing), with a clear and full description. Certainly it is quite worth while to draw attention to Besler's figure and text, but it tells one nothing new. There are good figures in Gerarde, 1597, and Clusius, 1601, Besler's being 1613. "The potato," another correspondent writes, "is not *wild* in Virginia; it must have been carried there from Peru and Chili. The only wild United States potatoes are high up in the Rocky Mountains. A. De Candolle's idea is that the potato was first brought to Europe, not by the English, but by the Spaniards."

THE additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Anthropopithecus troglodytes* ♀) from West Africa, presented by Capt. Reginald E. Firminger; a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr. G. Ballentyne; a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mrs. S. M. Grove-Grady; a Banded Ichneumon (*Herpestes fasciatus*) from West Africa, presented by Mr. G. F. Stimpson; two Egyptian Geese (*Chenalopex ægyptiaca*) from Africa, presented by Col. Harris Burland; a Larger Hill-Mynah (*Gracula intermedia*) from India, presented by Miss Maud Bendall; a Martinique Gallinule (*Ionornis martinicus*) from South America, presented by Mr. W. J. Rae; Aldrovandi's Skinks (*Plestiodon auratus*) from North-West Africa, presented by the Hon. Walter de Rothschild; a Geometric Tortoise (*Testudo geometrica*), a Semiserrated Tortoise (*Testudo semiserrata*), an Angulated Tortoise (*Chersina angulata*), two Dwarf Chameleons (*Chamæleon pumilus*), two Keeled Euprepes (*Euprepres carinatus*), a Spotted Slowworm (*Acontias meleagris*), a Bipes (*Scelotes bipes*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S; a Sand Lizard (*Lacerta agilis*), European, presented by Master Stanley S. Flower; two Ruffs (*Machetes pugnax*), a Common Viper (*Vipera berus*), British, deposited; a Silver-backed Fox (*Canis chama*) from South Africa, twelve Black-tailed Godwits (*Limosa ægocephala*), European, purchased; a Thar (*Capra jemlaica*), a Pigmy Hog (*Porcula salvania*), twelve Mandarin Ducks (*Æx galericulata*), a Chilian Pintail (*Dafila spinicauda*), a Red-crested Pochard (*Fuligula rufina*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

BLACK TRANSIT OF JUPITER'S FOURTH SATELLITE.—The fourth satellite of Jupiter was observed in black transit by Mr. E. E. Barnard of Nashville, Tenn., U.S.A., on May 8 with a 6-inch refractor. It was first noticed as a black spot at 9h. 20m. local mean time. Some little time previous to this it had been looked for on the disk but could not be seen either as a white or dark spot. The satellite was followed until 9h. 43m., and was then very black and rather small and round when best seen.

COMETS BROOKS I. and III.—The following ephemeris for Comet Brooks I. is by Dr. A. Berberich (*Astron. Nachr.*, No. 2731):—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log r	Log Δ	Brightness
July 3	8 11 33	8 43·6 S.	9·8945	0·1128	2·0
7	8 37 32	9 49·2	9·9405	0·1400	1·4
11	9 0 24	10 37·4	9·9811	0·1680	1·0
15	9 20 32	11 13·6	0·0172	0·1957	0·8
19	9 38 22	11 41·5	0·0498	0·2227	0·6
23	9 54 15	12 3·9	0·0794	0·2487	0·5
27	10 8 30	12 22·7	0·1064	0·2734	0·4
31	10 21 25	12 39·1 S.	0·1314	0·2969	0·3

The brightness on April 29 is taken as unity.

Comet Brooks III. is now very faint, and will be soon altogether out of sight. Dr. S. Oppenheim gives (*Astron. Nachr.*, No. 2735) the following places for Berlin midnight on July 4 and 8:—

	R.A. h. m. s.	Decl. ° ′
July 4,	13 18 40	16 42·6 S.
8,	13 29 17	18 48·3 S.

NOVA ORIONIS.—The new star discovered by Mr. J. E. Gore near χ_1 Orionis appears for some unexplained reason to be a difficult object for photometric observations, the estimates of its magnitude made by various observers differing remarkably. Thus Dr. G. Müller found it a little brighter than the 6th magnitude in the last days of December 1885—December 19, 5·86 m.; December 20, 5·76 m.; December 30, 6·00. Profs. Glasenapp and Pritchard both found it considerably fainter than the 6th at this time, the former giving it as 6·7 m. on December 30, the latter 6·42 m. on December 28. Profs. Müller and Pritchard give closely accordant results for the middle of January 1886, the magnitude being about 6·8 m, whilst Prof. Glasenapp and Mr. Gore found it about 7½ m. at the same time. Profs. Pritchard and Müller disagree a little later on, and differ by a full magnitude at the end of February and beginning of March, the former regarding the star as about the 7th magnitude, the latter about the 8th, whilst MM. Glasenapp and Gore consider it as nearly the 9th. There is a better agreement amongst three of the observers as to the range of magnitude through which the star has passed; Dr. Müller and Mr. Gore, agreeing in giving 2·4 m. for the change from about December 20 to March 8, and Prof. Glasenapp finding nearly the same value, but Prof. Pritchard, on the other hand, only finds a change in the same period of about seven-tenths of a magnitude.

10 SAGITTÆ.—Mr. Espin, in *Circular* No. 5 of the Liverpool Astronomical Society, gives the interval from maximum to minimum for this star as 4·4d.; maxima for July, 1·6d., 9·9d., 18·3d., 26·6d.; minima, 6·1d., 14·4d., 22·7d., 31·0d.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *JULY* 4–10

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 4

Sun rises, 3h. 52m.; souths, 12h. 4m. 6·4s.; sets, 20h. 16m.; decl. on meridian, 22° 53′ N.: Sidereal Time at Sunset, 15h. 7m.

Moon (three days after New) rises, 7h. 7m.; souths, 14h. 36m.; sets, 21h. 53m.; decl. on meridian, 13° 19′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	5 42	13 39	21 36	20 33 N.
Venus	1 36	9 24	17 12	19 13 N.
Mars	11 14	17 16	23 18	0 23 S.
Jupiter	10 53	17 6	23 19	1 44 N.
Saturn	3 53	12 2	20 11	22 30 N.

July	h.	
4	2	Saturn in conjunction with the Sun.
7	7	Jupiter in conjunction with and 0° 33′ south of the Moon.
7	13	Mars in conjunction with and 2° 1′ south of the Moon.

Variable Stars

Star	R.A. h. m.	Decl. ° ′			h. m.	
U Cephei	0 52·2	81 16 N.	July	4,	0 33	*m*
			,,	9,	0 13	*m*
Algol	3 0·8	40 31 N.	,,	5,	3 16	*m*
R Bootis	14 32·2	27 14 N.	,,	8,		*M*
δ Libræ	14 54·9	8 4 S.	,,	10,	22 40	*m*
U Coronæ	15 13·6	32 4 N.	,,	8,	2 57	*m*
S Herculis	16 46·7	15 8 N.	,,	4,		*m*
R Ophiuchi	17 1·2	15 56 S.	,,	4,		*M*
U Ophiuchi	17 10·8	1 20 N.	,,	7,	0 40	*m*
X Sagittarii	17 40·4	27 47 S.	,,	10,	2 0	*M*
β Lyræ	18 45·9	33 14 N.	,,	9,	21 30	*M*

M signifies maximum; *m* minimum.

NATIONAL SMOKE ABATEMENT INSTITUTION[1]

DURING the year the interest in the subject of smoke prevention and in improved apparatus for the consumption of fuel has been steadily increasing, and the gradual extension of knowledge on the subject has led the general public to take a much more intelligent and active interest in the question of smoke abatement, which was at first considered by the great majority of the community to be almost a sentimental evil rather than a matter entering into the calculation and care of ordinary life. The Council regret, however, to note that the Annual Report of the Commissioner of Police, issued in August last, is strangely deficient with regard to information as to the operation of the Metropolitan Smoke Abatement Acts, which are administered by the police; and the Council thought it their duty to write to the *Times* and other daily papers, calling attention to this want of information in the Report, and also to the very anomalous character of the fines inflicted in the case of convictions; they also laid the matter before the Home Secretary, calling special attention to the following facts—

(1) That in numerous cases of nuisance which are reported by the police no proceedings are taken.

(2) That when proceedings are instituted, and convictions obtained, the penalties inflicted by the magistrates do not comply with the Acts of 1853-56, the average fine being below the legal minimum.

(3) That no proceedings whatever appear to be taken to enforce the abatement of smoke from steamers, &c., on the River Thames, although an enormous quantity of smoke is evolved by them, causing a very serious nuisance, not only in the waterside districts, but by polluting the general atmosphere of the metropolis.

(4) That such great development has taken place during the last few years in the methods of preventing smoke from the works falling under the provisions of the statutes, that they may be more rigidly enforced without hardship.

(5) That the area within which the Smoke Abatement Acts apply no longer corresponds with the area within which smoke is produced.

The Council were supported in thus calling the attention of the Home Secretary to the matter, by the fact that the Annual Report of the Commissioner of Police for the preceding year (1883) remarks strongly on the inadequacy of the fines, and states that, "The fact of recent changes in heating systems having brought about some very considerable commercial advantages of various kinds, has operated in a marked degree in mitigating hostility to the enforcement of the Acts."

The Council have also, through the medium of the Press, called attention to the fact that the London School Board are neglecting a public duty and losing a valuable opportunity of instructing the public, by having the large buildings recently erected for schools fitted up with heating apparatus without due regard to their smoke-consuming capabilites.

They have also endeavoured to influence public opinion by bringing under notice pledges which appear to have been given by some Parliamentary candidates, that they would endeavour to exempt bakers from the operation of the Smoke Abatement Acts, this pledge having been obtained by certain bakers who wished to maintain the use of a particular class of furnaces which ordinarily produce a large amount of smoke. It is scarcely necessary to point out that the exemption of bakers from the operation of the Smoke Nuisance Acts would be prejudicial to the public interest, as it is a fact that smoke can be and is in some bakeries entirely prevented, not only to the advantage of the public, but also to that of the men who work in the bakeries. The Parliamentary candidates themselves were also communicated with upon the subject.

The unreasonableness of the suggestion that bakers should be exempt from the provisions of the Smoke Acts is the more noticeable from the fact that the Commissioner of Police, in his Annual Report for 1883, alluding to the general improvement of heating methods, says: "The most important changes perhaps have been made in the case of bakers' and confectioners' oven furnaces, which have hitherto caused, and still continue to cause, the greatest number of offences charged under the Smoke Acts. Some of them are now adapted by a simple alteration, which can be made without stoppage of the daily trade, to the use of gaseous fuel (ordinary coal gas mixed with atmospheric air), instead of coal; while other ovens are heated by coke applied either directly to the purpose, or by steam, which is generated in pipes heated by means of coke-fired furnaces."

It may be added that the Council have had before them an offer from a good firm of oven builders, stating that they are prepared to fit up fifty bakers' ovens at half price, to prove the practical working of one system rendering such ovens entirely smokeless.

In various trades, notably baking confectionery, tile and porcelain burning, glass staining, japanning, &c., considerable advantages, in addition to the prevention of smoke, have been found to result from the use of coal gas instead of solid fuel for

[1] Report of Council of the National Smoke Abatement Institution, submitted at the ordinary general meeting, December 18, 1885.

furnaces and engines, but to obtain the same result the cost of gas is greater than that of coal. Although the directors of the gas companies of the Metropolis are apparently not unwilling to advance the cause of smoke abatement, and thereby of public sanitation, by making a reduction in the price of gas used for trade purposes, they are prevented doing so by their Acts of Parliament. The Council are keeping the matter in view, and watching a favourable opportunity to urge the Government to grant the necessary powers.

Correspondence has been carried on on the subject of the gas stoves at the Bank of England, insisting on the necessity of flues being provided to carry off the products of combustion from all gas stoves used for warming purposes, and letters have been received thanking the Institution on behalf of the clerks for calling the attention of the Bank authorities to the matter. Voluminous correspondence has also been carried on with makers and inventors of stoves and smoke-prevention appliances, and of patent fuels, and with others, giving information and suggestions on points connected with the subject too various to be set out.

During the year several tests have been carried out by the Institution, and they have now under consideration the preparation of another volume of detailed reports of tests. The volume would include tests of various forms of furnaces, steam and other boilers, blow-pipe furnaces, smoke-preventing appliances, ventilating fans, non-conducting compositions, mechanical stokers, condensers, gas cooking and heating stoves, and various heating and cooking appliances using gas and coal as fuel.

The Council had at one time intended to exhibit at the Parkes Museum typical forms of heating and smoke-abatement appliances, but for various reasons they considered it undesirable to carry out the scheme, and they propose instead to promote periodical exhibitions of special heating apparatus, or new methods of heating and smoke prevention, as opportunity may offer.

In connection with this branch of the subject, reference may be made to the exhibition of the Sanitary Institute held at Leicester in September, at which various stoves and smoke-preventing appliances were exhibited. Exhibitions of gas stoves for heating and cooking purposes have also been held in many of the chief provincial towns during the year.

A memorial, praying for a grant from the surplus funds of the International Health Exhibition, signed by the Duke of Westminster and other influential persons, was unavailing, although the object of this Institution so directly affects public health, the improvement of which was the avowed aim of the Health Exhibition. This is much to be regretted, as the lack of funds not only militated against the general operations of the Institution, but it prevented the Council establishing a testing department, which is a necessary adjunct to the Institution for the advancement of its objects.

During the year a lecture given in the Parkes Museum by Mr. T. Fletcher, of Warrington, on Smoke Abatement, and a pamphlet containing three prize essays on the same subject, have been printed by the Institution and circulated. A paper by Mr. W. R. E. Coles, on the Hygienic, Moral, and Economic Aspects of the Smoke Question, read at the Leicester Congress of the Sanitary Institute, is now being prepared for circulation.

By order, E. WHITE WALLIS,
Secretary

THE WINGS OF BIRDS[1]

THE power of flying through the air is one of the principal characteristics of the class of birds. Although some members of the other great divisions of the Vertebrates—the bats among Mammals, the extinct pterodactyle among Reptiles, the flying-fishes among Pisces—possess this power in a greater or less degree, these are all exceptional forms, whereas in birds the faculty of flight is the rule, its absence the exception. Among Invertebrates this power is possessed in a very complete degree by the greater number of insects.

In the normal structure of the vertebrate animals there are two pairs of limbs, anterior and posterior, never more. It often happens, however, that one pair, and sometimes both, are suppressed, being rudimentary, functionless, or entirely absent. Flight is always performed by the anterior or pectoral pair, more or less modified for the purpose. The super-addition of wings to arms, as in the pictorial representations of angels, has no counterpart in nature. The wings of the bird, the bat, the pterodactyle, and flying-fish, are the homologues of the arms of man, the fore-legs of beasts. In the flying-fish the power is gained simply by an enlargement of the pectoral fin, and the function is very imperfect; in the pterodactyle, by immense elongation of one (the outer) finger, and extension of the skin between it and the side of the body; in the bats, by elongation of the four outer fingers, and extension of a web of skin between them and the body. In the bird the flying organ is constructed mainly of epidermic structures, peculiar outgrowths from the surface, called *feathers*—modifications of the same tissue which constitutes the hair, horns, scales, or nails of other animals. Feathers are met with only in birds, and are found in all the existing members of the class, constituting the general covering of the surface of the body.

The framework to which the broad expanse formed by the feathers is attached is composed of bones, essentially resembling those of the fore-limb of other Vertebrates. The distal segment, manus, or hand, in the vast majority of birds, has three metacarpal bones and digits, the former being more or less united together in the adult state. The digits appear to correspond with the pollex, index, and medius of the typical pentadactyle manus; the second is always the longest. Both it and the pollex frequently bear small horny claws at their extremity, concealed among the feathers and functionless, but very significant in relation to the probable original condition of the avian wing. These claws are altogether distinct from the large, and often functional, spurs developed in many species from the edge of the metacarpal bones, resembling both in use and situation the corresponding weapons in the hind-feet The third digit does not bear a second phalanx or claw in any existing bird.

The quills, remiges, or flight-feathers attached to the bones of the manus (called "primaries"), never exceed twelve in number, and are (as has been recently shown by Mr Wray) in the very great majority of birds distributed as follows:—Six, or in some few cases (flamingo, storks, grebes, &c.), seven to the metacarpus; of the remainder or digital feathers, one (*ad-digital*) is attached close to the metacarpo-phalangeal articulation, and rests on the phalanx of the third digit; two (*mid-digital*) have their bases attached to the broad dorsal surface of the basal phalanx of the second digit, which is grooved to receive them; the remainder (*præ-digital*) are attached to the second phalanx of the same digit. These last vary greatly in development, in fact their variations constitute the most important structural differences of the wing. In most birds there are two; the proximal one well developed, the distal always rudimentary; but the former may show every degree of shortening, until it becomes quite rudimentary, or even altogether absent, as in *Fringillidæ* and other "nine-primaried" birds, in which there are six metacarpal remiges, one ad-digital, two mid-digital, and no præ-digitals, or only a very rudimentary one. The smaller feathers at the base of the quills, called upper and under coverts, have an equally regular arrangement. The webs or vanes of all the flight-feathers are made up of a series of parallel "barbs" which cohere together by means of minute hooklets, and so present a continuous, solid, resisting surface to the air.

Such is the characteristic structure of the wing in almost all carinate birds, whether powerfully developed for flight, as in the eagles, albatrosses, or swifts, or whether reduced in size and power to practically useless organs, as in the extinct great auk, the dodo and its kindred, weka rail, notornis, cnemiornis, &c., most of which, being inhabitants of islands containing no destructive land mammals, appear to have lost the principal inducement, and with it the power, to fly.

In the penguins (*Spheniscomorphæ*) the feathery covering of the wing entirely departs from the normal type. Each feather is like a flattened scale frayed out at the edges, the barbs are non-coherent and have no hooklets. They form an imbricated covering of both surfaces of the wing, including the broad patagium which extends from the cubital side of the limb, but appear to have no definite relation to the bones, and cannot be divided into distinct groups, corresponding to those described above. The structure of the wing separates the penguins sharply from all the other carinate birds.

The Ratitæ, or birds without keel to the sternum, form another very distinct group, distinguished by the rudimentary or imperfect condition of the remiges or quills, which never have coherent barbs, and are therefore unfitted to the purpose of flight. In the ostrich and rhea the bones, though comparatively

[1] Abstract of Lecture by Prof. W. H. Flower, LL.D., F.R.S., at the Royal Institution, February 19, 1886.

small, are distinct and complete, and the feathers large and definitely arranged. The emu, cassowary, and apteryx show various degrees of degeneration, which apparently culminated in the dinornis, no trace of a wing-bone of which bird has ever been found. The question which naturally presents itself with regard to these birds is, whether they represent a stage through which all have passed before acquiring perfect wings, or whether they are descendants of birds which had once such wings, but which have become degraded by want of use. In the absence of palæontological evidence it is difficult to decide this point. The complete structure of the bony framework of the ostrich's wing, with its two distinct claws, rather points to its direct descent from the reptilian hand, without ever having passed through the stage of a flying organ. The function of locomotion being entirely performed by powerfully developed hind-legs, and the beak mounted on the long flexible neck being sufficient for the offices commonly performed by hands, the fore-limbs appear to have degenerated or disappeared, just as the hind-limbs of the whales disappeared when their locomotory functions were transferred to the tail. This view is strengthened by the great light that has been thrown on the origin of the wings of the flying birds by the fortunate discovery of the *Archæopteryx* of the Solenhofen beds of Jurassic age, as in this most remarkable animal, half lizard and half bird, the process of modification from hand to perfect flying bird is clearly demonstrated. The three digits which in the existing forms are more or less pressed together and imperfect, still retain their freedom and complete number of phalanges, and are each armed with terminal claws, while the flight feathers and remiges of the cubital, metacarpal, and digital series are fully developed and evidently functional. The earlier stages in which the outer digits were still present, and the feathers imperfectly formed or merely altered scales, are not yet in evidence.

Some conception of the process by which a wing may have been formed may also be derived from the study of the growth of feathers on the feet of some domestic varieties of pigeons and poultry, illustrations of which were shown at the lecture.

THE SUN AND STARS[1]

VII.

WE have now to endeavour to apply to the more distant stars some of the facts which I have brought before you touching the nearest one—our sun. What we have to do in the short time at our disposal is to choose those facts which will give us the greatest amount of knowledge concerning the greatest number of those stars.

When the star that is nearest to us has set, the number of stars which a pair of eyes can see on a dark night, whether they happen to be north of the equator or south of it—for the number of stars is pretty equally distributed north and south—is something under 3000. But when we leave behind us the power of the unaided eye, and consider what results can be obtained by the optical means now at man's disposal, we have to increase these 6000 to something like forty or fifty millions, so that, if we can by any chance obtain facts touching one star that are applicable to others, we do a great deal. We are, in fact, dealing with 50,000,000 bodies instead of one.

The first thing regarding these distant bodies to which I have to draw attention is that they have been divided for purposes of convenience—astronomical and other—into magnitudes such that the first magnitude means the brightest star we can see; and so we go on till now we go down to the sixteenth magnitude.

The order of diminution of brightness is not quite exact from the first magnitude to the faintest visible to the naked eye, but it may be taken on the average to be about two-fifths. If we take this ratio as the normal one down to the sixteenth magnitude we get the following values nearly :—

2½ stars	2nd mag.	=	1 star 1st mag.
6	3rd	=	,,
16	4th	=	,,
40	5th	=	,,
100	6th	=	,,
⋮	⋮		
10,000	11th	—	,,
⋮	⋮		
1,000,000	16th	=	,,

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 45.

We not only get the stars thus visible, but, as they can be photographed in a certain period of time, this period measures their photographic brightness. We find, for instance, that a first magnitude star can be photographed in the three-thousandth part of a second ; that a star of the seventh magnitude can be photographed in about one second ; and when we come to the twelfth magnitude we must turn seconds into minutes, and we shall require two of them to get an impression on the plate ; till, working on gradually to the sixteenth magnitude, we find that the photographic plate, which requires only the three-thousandth part of a second for a star of the first magnitude, requires one hour and twenty-three minutes (or eighty-three minutes) to receive the impression, we find the ratio of two-and-a-half times to be practically indicated by the times of exposure.

The relative photographic light of stars of all magnitudes when the most rapid dry plates are used is shown in the following table :—

Magnitude	Time of exposure m.	s.
1st		0·005
2nd		0·013
3rd		0·03
4th		0·08
5th		0.2
6th		0·5
7th		1·3
8th		3·0
9th		8·0
10th		20·0
11th		50·0
12th	2·0	
13th	5·0	
14th	13·0	
15th	33·0	
16th	83·0	

We must not for one moment imagine that, because for many reasons it has been necessary to divide stars into magnitudes, all the stars are of exactly the same size at different distances, or of different sizes at the same distance. We know very little at present relatively. But this we do know, every new fact has shown us that some of the apparently fainter stars may be very large, and some of apparently the brightest stars may be small. You can understand that the light which we get from the stars will depend upon these two things. Take the case of the sun, for instance. We know that the sun is a small star, and yet it gives us a great deal of light because it is near to us. We know that some of the other stars are very distant, and they give us a small amount of light, not because they are small, but because they are so far away.

We are living now in a very interesting time, because people are beginning to work here and there, not in too many places, to get the stars to write their own autobiography, so to speak. In fact, a very important attempt is being made at the present moment to replace observations of the positions of the stars by actual photographs. Observations, you know, being human, are always liable to error. This plate, which I am about to show you, is a photograph that I have received from the Brothers Henry of Paris only this morning, showing what photography can do in registering the exact positions and brightnesses of an almost innumerable army of stars by simply exposing a plate in a telescope.

If it is wished to obtain photographs of stars of the sixteenth magnitude, the plate will have to be exposed eighty-three minutes. If we are content to get stars of the seventh magnitude, then two minutes will be enough.

All the stars that you see here are visible in a very restricted portion of the sky in the constellation Cygnus, not very far from the Milky Way. You can understand what a happy thing it will be for the astronomer of the future if, when he wants to know the state of the heavens in this nineteenth century, instead of having to consult musty books of observations which may probably be wrong, he can refer to a book of which the leaves are made of glass, and on which is recorded the autobiography of every square degree of the heavens as you see on this diagram before you.

In our attempt to apply to these other bodies the knowledge which we have acquired touching the sun, of course we have to consider chiefly the light sent to us by them. You will see in a moment that if the sun were very much farther away from us than it really is—imagine it for a moment so far away that instead of appearing to us with a disk it should appear to us as a star, like Sirius or Capella, for instance—the only difference between its spectrum now and its spectrum then would be that there would be less of it. There would be less light. Consequently it would not be possible for us to see it in all its exquisite detail. But so far as the spectrum went there would be no change in kind, although there might be a change in degree.

Now, if you just assume that for a moment, you see that we shall be in a very fair way to make a very important application of this knowledge, because I was careful to tell you that in the solar system we have indications of a considerable amount of absorption of blue light; so that, if the sun's atmosphere were away and the earth's atmosphere were away, the sunlight, if we are now right in calling it white, would then certainly appear to us as blue, for the reason that the blue light now stopped by the sun's atmosphere and by our own would then be added to the light which we get at the present moment, and the total light therefore received by our eyes would be very much richer in blue rays than it is at present.

Now then, having the fact of this blue absorption in our minds, let us suppose it—to begin with the simplest case—to be enormously increased. Let the blue absorption creep on into the spectrum till at last it reaches the green or the yellow or the red. It is clear that then the sun that we should see would be a red sun, and that sunlight would be no longer white, but red.

Let us next, on the other hand, reduce the quantity of the existing blue absorption. Let us have a solar spectrum as long as the spectrum of the electric light, for instance.

Now let us do something else. Let us suppose that in the solar spectrum, as in very many of the spectra that we can observe in our laboratories, there is superadded to this blue absorption a strong absorption of the red, beginning at the other end of the spectrum. We shall get the yellow and the red, say, absorbed on the one side of the spectrum, while we get the blue and violet absorbed on the other. We shall therefore only get the green light to pass.

Do we get evidence that in the heavens among other stars such conditions as these hold? Certainly. A very considerable number of the stars in the heavens are called coloured stars. They are red, or they are blue, or they are green, for the most part, and you see that simply dealing with the absorption of the blue with which we have become familiar in the case of the sun, playing with it a little, giving it a little rope here, shortening the rope there, and adding another exactly equivalent absorption at the other end of the spectrum, we can at once account simply and sufficiently for the colours of the coloured stars. This is one advantage that we have in working from the known to the unknown. If we had begun with the stars and dealt with their phenomena first, it would have been difficult to explain; but now that we know how a thing happens in the case of the sun, it is quite easy for us to imagine the mechanism which must be at work in the atmosphere of the coloured stars to give us in some cases red suns, in others green suns, and in others still blue suns.

So much then for coloured stars.

There is another matter. As I shall have to show you by and by, one of the most important distinctions between the stars in the heavens is one not depending upon their magnitudes, not depending upon their distances, or upon their mass, or upon anything of that kind, but depending upon conditions which we do not know very much about at present, but which bring about this result, that the spectrum in one case is different from the spectrum in another, exactly as in our laboratories we find the spectra of bodies with which we are perfectly acquainted become different if the temperature which we employ is made to differ. For instance, in the case of the vapour of carbon we may employ a low temperature, and get a certain spectrum of the vapour which is called a spectrum of flutings. If we increase the temperature, and then again observe, the flutings have disappeared. They have given way to a system of lines in which the irregularity is just as striking as the exquisite rhythm of the flutings was in the former case. From hundreds of these observations the student of spectrum analysis is not afraid to say that when he sees a spectrum of flutings he knows that he is dealing with the action of vapours at a much lower temperature than exists in those conditions in which the flutings are replaced by lines. And, more than that, so definite is this, so much do we know about the fluted spectra of those substances which exist in the solar atmosphere—giving us, at the temperature of the sun, the line spectrum—that it is easy for us to take the responsibility also of saying that, if the sun's atmosphere were to be suddenly cooled to-morrow, we should get a spectrum of flutings, instead of a spectrum of lines; so that when we get, if we do get, the fluted spectrum in the spectrum of a star, we are justified in saying that some cause has been at work in that star equivalent to a cooling process in the atmosphere of our own star. Thus, if we cooled the sun to-morrow we should produce the spectrum of flutings, and as in cooling down the sun will in all probability pass through a stage indicated by flutings, so also while it was acquiring its present temperature it passed through the same stage.

What, on the other hand, would happen if we had the sun very much hotter to-morrow? It is important to think this out very carefully. According to the views which I have brought before you, we have, outside all, solids absorbing every part of the spectrum. Then we have liquids and dense vapours doing the same: less dense vapours absorbing the red, and finer vapours still absorbing the blue. We have flutings also, but chiefly we have vapours at an enormous temperature which give us the familiar absorption spectrum of Fraunhofer lines.

We have the Fraunhofer spectrum in short giving us the summation of the line absorption of every stratum in the sun's atmosphere. We have also a wonderfully simple spectrum of the chromosphere, of which I gave you the list of lines, writing down for us the absorption of the hottest part of the sun's atmosphere that we can get at.

Now try to think this out quite completely.

The first obvious thing which will strike us is that, if the sun could be made hotter to-morrow than it is to-day, the thing that we should be quite certain about, whatever might happen to the other conditions, would be that the gases which give us that simple spectrum of the chromosphere would have a larger share in the absorption-spectrum, and that therefore the absorption-spectrum of the star would gradually get nearer and nearer to the absorption-spectrum which would be given by the chromosphere itself if it could be seen in all its simplicity. I think that way of reasoning is right. Well, if you think it is, you will find that it will lead us to a very interesting conclusion. If we find any star with practically the spectrum of the chromosphere, we shall be bound to admit that the atmosphere of that star must be hotter than the *average* temperature of the atmosphere of our sun as its spectrum approaches that of the *hottest* part of the sun's atmosphere.

There is one other point that I have to bring before you before I go further, and it is this. We have had a great deal to say about the photosphere of the sun and the surrounding envelopes. We saw that when any vapours were located between our eye and the bright sun in the centre we then got absorption-lines, for the reason that the sun was hotter than the vapour on this side of the sun, so to speak, and therefore light was stopped by the cooler vapour in the atmosphere, and we got a dark line. The moment however, we work outside the disk, and study a prominence on the limb of the sun, or even a part of the corona, we observe them by means of their bright lines—by means of their radiation. There is no hotter light source behind them, and therefore we deal simply with radiation.

Now, that being so, you will understand how it is that in the general spectrum of the sun all the lines are dark, because we found that while the bright central part of the sun was not very much less than the whole volume, something like a tenth, it was very much hotter, so that we get many thousand times more light from the centre of the sun. If a substance in the outer atmosphere gives us a bright line corresponding with a dark line given us from this central portion due to the atmospheric absorption, all it can do is to reduce the intensity of the dark line produced by the intensely illuminated central portion.

It is a question of area. The difference of area is small, smaller than the difference of illumination, and therefore anything which happens outside does not get its record written at all, the area being five or six to one, and the intensity of the light in the centre being, say, ten thousand to one.

Now let us consider another case. Let us suppose that there is a star (never mind which it is) the atmosphere of which is so enormous that its diameter to the diameter of the central photosphere is represented by two concentric circles—one very large, the other very small. Here the difference of area between the inner circle, which gives us dark lines, and the larger exterior space, which gives us bright lines, if it gives us anything, is so enormous that it may be greater than the difference of the intensity of the light; so that if the inner light is ten times brighter than the light which comes from the outer area, which, let us say, is a couple of hundred times greater, in that case we shall be bound to have bright lines from the exterior regions mixing with the dark lines coming from the interior regions. Hence we see that the spectra which we may get from stars will not depend upon the diameter of the stars at all, but may depend upon the difference of area simply which we should get by cutting a section at right angles to the line of sight from the earth through the star and its whole atmosphere.

It comes to this: Suppose some stars have very large coronal atmospheres; if the area of the coronal atmosphere is small compared with the area of the section of the true disk of the sun, of course we shall get an ordinary spectrum of the star; that is to say, we shall get the indications of absorption which make us class the stars apart; we shall get a continuous spectrum barred by dark lines. But suppose that the area of the coronal atmosphere is something very considerable indeed, let us assume that it has an area, say fifty times greater than the section of the kernel of the star itself; now, although each unit of surface of that coronal atmosphere may be much less luminous than an equal unit of surface of the true star at the centre, yet if the area be very large, the spectroscopic writing of that large area will become visible side by side with the dark lines due to the brilliant region in the centre where we can study absorption; other lines (bright ones) proceeding from the exterior portion of that star will be visible in the spectrum of the apparent *point* we call a star.[1]

Those things, then, being premised, we are now in a position to approach the subject of stellar spectra. Much work is now being done in this direction, but we must not forget the early workers. We must not forget that it was Fraunhofer at the beginning of this century who first saw and carefully observed several spectra of stars, and we must be all the more careful to remember that, since really more than half a century passed before anybody took the trouble either to repeat his observations or to extend them. Some twenty years ago, however, several observations had been brought together by the labours of Italian and American men of science (scarcely a stellar spectrum had been observed in England). This enabled a distinguished American, Mr. Rutherfurd, to begin to put a little order into the facts which had so far been acquired.

He pointed out that it was easy to arrange these stars into classes—that all the spectra were not alike. There was a wonderful family likeness among three groups of them, and he showed that you might divide these spectra into three very definite classes. After him came two countrymen of our own, Dr. Huggins and Dr. Miller, who, when they did begin their work, certainly put into it an amount of vigour and assiduity which had never been approached before their time. They not only gave us careful drawings of the spectra of the stars which they

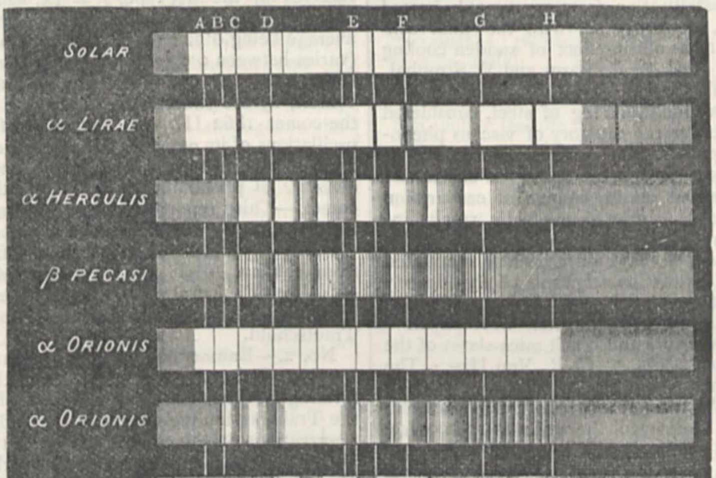


FIG. 21.—Various types of stellar spectra.

observed, but with infinite care and patience they made comparisons, as we may say, to determine the origin of the lines in exactly the same way as I have pointed out that Kirchhoff, Ångström, and Thalèn discovered the origin of the lines in the spectrum of the sun. Indeed, they did not rest here, or rather, one of them did not rest here, for Dr. Huggins subsequently introduced a system of photography, and now, thanks to his skill, we have several photographs, of priceless value, of some of the brighter stars. And while I am lecturing to you here in London there is one observer in Berlin, Dr. Vogel, and another in the north of Europe, Dr. Dunop, doing all they can to give us a complete and perfect spectroscopic catalogue of every star that shines in the northern heavens, so that you can see that the work is going on.

Now, before I say any more about it, I will refer to a diagram which gives an idea of the kind of thing that one sees when these observations are being made.

We will just run through them one by one. There is a very rough and general view of the spectrum of the sun. The actual spectrum of the sun has been thrown on the screen before you, and therefore it will be quite understood that there we have a very rough copy of it for diagrammatic purposes, indicating merely the most obvious among the Fraunhofer lines. When we pass from the sun to α Lyræ, we pass from a star having a relatively large number of lines to one having a small number; and this small number of lines is further remarkable from the fact that the lines are much thicker than those seen ordinarily in the solar spectrum. Keeping to the stars which give us spectra of lines, here in α Orionis we get another case in which the lines do not occupy the places occupied by lines in the spectrum of the sun, nor, at the same time, are they so thick as the lines in stars of the Lyra type. We can also learn from this diagram, by the examination of the spectra of α Herculis and β Pegasi, that we get flutings from stars as well as lined spectra. We also see that these flutings are not all exactly in the same place, by which we can infer that the flutings are not all probably of the same chemical origin. Of that further by and by. The use of the diagram is to give a general idea. J. NORMAN LOCKYER

(*To be continued.*)

SCIENTIFIC SERIALS

The American Journal of Science, June.—The Biela meteors of November 27, 1885, by H. A. Newton. From a general survey of the observations made in various places, the author infers that the maximum of the shower was about 6h. 15m. Greenwich mean time; that the total hourly number of meteors visible at one place in a clear sky was at the utmost 75,000; that the densest part of the stream was not over 100,000 miles in thickness; that the meteors of November 27,

[1] *Proc.* Roy. Soc., No. 185, 1878.

1872 and 1885, did not leave the immediate neighbourhood of the Biela comet earlier than 1841-45, and may be treated as having at that time orbits osculating that of the comet.—The ultra-violet spectrum of cadmium, by Louis Bell. The ultra-violet spectrum of cadmium having long served as a standard of reference in the measuring of other spectra, an attempt is here made to determine its principal wave-lengths more accurately than is possible by Cornu's ingenious process. By taking photographs on Stanley instantaneous dry plates, Mr. Bell believes the wave-lengths here determined will be found correct to probably within 1/50,000 part of their respective values. The total number of lines accurately determined in the entire spectrum was thirty, of which the wave-lengths are tabulated with the corresponding figures obtained by Hartley and Cornu. —Communications from the United States Geological Survey, Rocky Mountains Division. The present communication (No. vii.) deals with the occurrence of topaz and garnet in lithophyses of rhyolites, and is contributed by Mr. Whitman Cross, who had already described the occurrence of minute crystals of topaz in the small drusy cavities of a coarsely crystalline rhyolite from Chalk Mountain, by Fremont's Pass, Colorado. The present specimens of topaz and small dark red garnets are from the trachyte on the Arkansas River, opposite Nathrop, Chaffee County, Colorado. The mode of formation of the topaz and garnet in the lithophysal cavities of the rhyolite in this district is not fully determinable, but they are evidently not secondary, but primary products, produced by sublimation or crystallisation from presumably heated solutions contemporaneous, or nearly so, with the final consolidation of the rocks.—On the strain-effect of sudden cooling exhibited by glass and by steel, by C. Barus and V. Strouhal. The experiments here described confirmed the views already announced by the authors, that the annealing of steel, considered physically, is at once referable to the category of viscous phenomena; also that the existence of the characteristic strain in glass-hard steel is the cause of electrical effects so enormous, that any additional effects caused by any change of carburation may be disregarded, and the electrical and magnetic results interpreted as due to variations in the intensity of the said strain. The chief results here arrived at have since been substantiated by polariscope evidence and by the investigation of the density of the consecutive shells of the "Prince Rupert drop." An account of these results will be given in their next paper.—Upon the origin of the mica-schists and black mica-slates of the Penokee-Gogebic iron-bearing series, by C. R. Van Hise. The iron-bearing formation of this region extends for over 80 miles from Lake Numakagon in Wisconsin to Lake Gogebic in Michigan; and at Penokee Gap, Wisconsin, the series is 13,000 feet thick, the upper 11,000 feet being mica-schists and black slates. The Muscovitic and biotitic greywacke, biotite-schists, and other formations here described furnish a graded series from the slightly altered greywackes to the crystalline mica-schists.—On two masses of meteoric iron of unusual interest, by Wm. Earl Hidden. One of these specimens, found on July 2, 1885, on a height to the east of Batesville, Independence County, Arkansas, weighs 94 lbs., and belongs to the class holosiderite of Brezina. It is specially remarkable for a hole piercing it near the edge, and cone-shaped from both sides. Analysis yielded: iron, 91·22; phosphorus, 0·16; nickel and cobalt, 8·62 by difference. The other, found in 1857 in Laurens County, South Carolina, weighs only 4 lbs. 11 oz., but is noted for the perfection of the Widmanstätter lines and unusual abundance of nickel and cobalt. Analysis: iron, 85·33; nickel, 13·34; cobalt, 0·87; phosphorus, 0·16, with trace of sulphur.—Notice of a new genus of Lower Silurian Brachiopoda, by S. W. Ford. This nearly perfect specimen of the ventral valve of the species described by E. Billings under the name of *Obolella desiderata*, and now preserved in the collection of Walter R. Billings, Ottawa, may be taken as the type of a new genus, probably including several described Lower Silurian species. It differs from *Obolella* in the form and arrangement of its muscular impressions, in the possession of a thinner shell and in other respects. The author, therefore, proposes for it the new generic name of Billingsia in honour of Mr. E. Billings, the late eminent palæontologist of the Canadian Geological Survey.

Bulletin de l'Académie Royale de Belgique, April 3.—Determination of the remainder in Gauss's quadrature formula, by M. Mansion. By a definite integral the author completes this formula, which thus becomes applicable to non-parabolic curves. —On some remains of cetaceans from the foot of the Caucasus, by M. P. J. Van Beneden. These remains, comprising portion of a skull with some vertebræ from the district east of Vladikavkas, and an almost perfect vertebral column, with ribs, radius, and humerus from the bed of the Kuban River, all belong to the same species, the *Cetotherium rathkei*, Brandt. By their means the author is enabled to determine the true characteristics of the Cetotherium, which shows some affinity to the Pachyacanthæ of the basin of the Danube, but was quite distinct from the extinct species of the Antwerp basin.—On some rocks dredged off the Ostend coast, by M. A. F. Renard. These include granites, porphyries, diorites, &c., such as occur along the French seaboard and in the Channel Islands; also Jurassic and Chalk formations identical with those of Boulogne and the cliffs of Dover. There is nothing to show that any of these rocks have been transported either from the south or from the Scandinavian regions during the Glacial epoch.

Bulletin de la Société des Naturalistes de Moscou, 1885, No. 1. —Revision of the numerical values of the repulsive force, by Prof. Th. Bredichin. In his preceding researches the author had determined it approximately by means of the rough formula of Bessel. Now, he corrects these results, either by direct evaluations by means of more exact formulæ, or indirectly by means of the isodynames constructed upon his rigorous formulæ. Taking 40 different comets (since 1472) M. Bredichin classifies them under three different types, and, on the former method, receives for the first type, $R = 14$, while the initial speed (due to the ejective force) varies between $g = 0·1$ and $g = 0·34$, the average being 0·22; for the second type, $R = 1·1$, and $g = 0·05$ (varies between 0·03 and 0·07); and for the third type, $R = 0·2$, and $g = 0·1$ to 0·2.—On the oscillation of the emissive of comets, by the same (with a plate). From a careful study of the comet 1862 III. the learned professor concludes that the oscillations of its emission ought to be considered beyond doubt, as they result not only from measurements, but also from all the *ensemble* of phenomena afforded by the head and tail of the comet.—Third report upon my herbarium, by Ed. Lindemann (in German).—Plantæ Raddeanæ Monopetalæ (continuation of Labiatæ), by Ferd. Herder.—Letters from Dr. A. Regel dated from Bokhara, Merv, &c., between May 1884 and April 1885. —Notice of a journey to Akhal-Tekke, by A. Becker, with a list of plants found at Kyzyl arvat.—On northern *Aucellæ*, by H. Trautschold.

No. 2.—Enumeration of the vascular plants of the Caucasus, by M. Smirnoff, continued from the preceding issue, and forming an introduction to the flora of the Caucasus.—Birds of the Transcaspian region, by M. Zaroudnoï.—Thirty-five years of observations on the earliest and latest times of blooming of wild and cultivated plants in the neighbourhood of Kishineff, by A. Dœngingk, followed by remarks on vegetable parasites and noxious insects. Four hundred plants are on the lists of the author.—Revision of the copulatric armatures of the males from the *Philereme* tribe, by Gen. Radoszkowski (with two plates). —The appendix contains the third part of the systematic catalogue of the herbarium of Moscow University, published by Prof. Goroshankin.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 13.—"On the Structure of Mucous Salivary Glands." By J. N. Langley, M.A., F.R.S., Fellow and Lecturer of Trinity College, Cambridge.

The cells of mucous salivary glands I have previously described as consisting of a framework or network, containing in its spaces hyaline substance and granules. The granules of the mucous salivary glands are rendered very distinct by irrigating a mounted specimen of a fresh gland with moderately dilute solutions of neutral or alkaline salts. In these fluids the granules can scarcely be distinguished from small fat globules; those of the submaxillary gland of the dog have a diameter of 1 to 2 μ. In the resting gland the granules are fairly closely packed throughout the cell, in a line stretching from basement membrane to lumen; there are 8 to 12 granules. Both hyaline substance and granules give rise to mucin.

During secretion both the hyaline substance and the granules are turned out of the cells; after prolonged secretion the cells consist of an outer zone, chiefly of freshly-formed substance, and of an inner zone of network, hyaline substance, and granules, as in the resting state. When the saliva has a high percentage of solids, both the hyaline substance and the granules can be seen in it. The hyaline substance is more soluble than are the granules, and is thus less commonly seen; it is partly dissolved, partly swollen up into a continuous mass; the less swollen parts appear as strings or blebs. The granules in saliva vary greatly in appearance; they may be very slightly swollen, and have fairly sharp outlines; or they may be more swollen and run together, forming pale masses of various size; occasionally in more dilute saliva they are just visible as pale spheres.

Although the mucous cells are able to turn out bodily their products, they do not disintegrate during secretion. As the decrease in the interfibrillar substance takes place, there is a fresh formation of substance in the outer part of the cells, *i.e.* as the cell secretes it also grows. In saliva there is no evidence of broken-down cells, nor are nuclei present except those in "salivary corpuscles," which, as stated by Pflüger, are leucocytes. Further, there is not any satisfactory proof that the demilune cells multiply during secretion, and give rise to mucous cells. During secretion there is no increase in the number of nuclei undergoing indirect division. As I have previously said, I hold the demilunes to be secreting cells of a different nature from that of the mucous cells. Glands with demilunes are simply glands in which the "albuminous" element is reduced to a minimum. The apparent increase in size of the demilunes, described by Lavdowsky as taking place in the first stage of secretory activity, I take to be due to the decrease in the size of the alveoli, so that the ordinarily flat demilunes become more spherical. Moreover, the demilune cells show signs of secretory activity. The "young" cells described by Heidenhain and by Lavdowsky are chiefly altered mucous cells.

The network of the cell consists of two parts—one in the cell-membrane, the other stretching from this throughout the cell. The peripheral network consists of very delicate fibres; at some of the nodal points there are small spherical swellings. From lumen to basement membrane there are twelve to fifteen meshes. The internal network is connected with the peripheral network, but it appears to me to have much larger meshes. From basement membrane to lumen there are in the submaxillary gland of the dog four to six meshes, *i.e.* the number of meshes in a given direction in the cell is about half that of the number of granules.

May 27.—"A General Theorem in Electrostatic Induction." By John Buchanan, B.Sc.

Part I. of this paper deals with the effect of change of the specific inductive capacity of a dielectric which is placed in a field of electric force, and it is proved that in general, under these circumstances, the dielectric becomes electrified.

By translating the theorem into the language of magnetism a theorem in magnetic induction is obtained.

The mathematical proof leads to an expression of the form

$$h = -\left(\frac{d\pi}{dV} - V\frac{d^2\pi}{dV^2}\right),$$

where h denotes the rate of change of the apparent electrification of the dielectric with regard to the specific inductive capacity as independent variable; π denotes the rate of change of the work done against electrical forces with regard to the same independent variable; and V denotes the potential.

The conditions that there may be no electrification of the dielectric are next obtained. The result is arrived at that, in order to have no electrification, when the specific inductive capacity is altered, the whole field of force must be occupied by an electrically homogeneous dielectric. It is then pointed out that the equations obtained express the effect of heterogeneity in the constitution of the dielectric medium.

In Part II. the above theorem and some of the results obtained by Dr. Kerr in his experiments in "electro-optics," are applied to obtain a theory of electrification by friction.

The discussion leads to these conclusions:—

"Positive" liquids tend to become positively electrified by friction.
"Negative" ,, ,, negatively ,, ,,
"Positive" solids ,, negatively ,, ,,
"Negative" ,, ,, positively ,, ,,

All these conclusions are verified by the experimental results given in the paper.

June 10.—"Fluted Craterless Carbons for Arc Lighting." By Sir James N. Douglass.

On December 8, 1858, at the South Foreland High Lighthouse, and with the direct current magnetic machines of Holmes, the first important application of the electric arc light, as a rival to oil and gas for coast lighting, was carried out by the Trinity House, under the advice of Faraday.

The carbons then used, and for several years afterwards, were sawn from the residuum carbon of gas retorts; they were square in section, $6\frac{1}{4} \times 6\frac{1}{4}$ mm., and the mean intensity of the arc measured in the horizontal plane was 670 candle units, being 17 candle units per square millimetre of cross-sectional area of the carbon. The crater formed at the point of the upper carbon of the "Holmes" lamp was so small that no appreciable loss of light was found to occur, and the arc proved to be very perfect in affording an exceptionally large vertical angle of radiant light for application with the optical apparatus.

The most reliable and efficient machine that has yet been tried for lighthouse purposes is the large size alternate current magneto machines of De Meritens. The average results with these machines are as follows, viz.:—

	One machine	Two machines supplying current to one lamp
E.M.F.	38 volts	48 volts.
Mean current	206 amperes	372 amperes.
Carbons (cylindrical) ...	35 mm. diam. ...	50 mm. diam.
Diameter of crater in carbon	13 mm.	18 mm.
Mean intensity of arc measured in the horizontal plane (candle units) ..	15,000	30,000
Light per square millimetre of carbon section (candle units)	12	12

It will be observed from this statement that the intensity of the arc in the horizontal plane per square millimetre of sectional area of carbon is about 35 per cent. less than it was with the small square carbons used by "Holmes," although it might reasonably be expected that with the improvements since effected in the manufacture of carbons, the efficiency of the old carbons would at least be maintained. The relative inefficiency of the large carbons used with the powerful currents now available appears to be due (1) to the loss of a large portion of the most intense part of the arc which is confined within the crater of each carbon; and (2) to the fluctuations in the intensity of the arc caused by the current passing between various points of the end of each carbon.

For a new electric light installation about to be made by the Trinity House at St. Catharine's Lighthouse, Isle of Wight, it is intended to utilise the large De Meritens machines that were used at the recent South Foreland experiments for determining the relative merits of electricity, gas, and oil as lighthouse illuminants. The electric light at St. Catharine's is intended to be "single-flashing" at periods of 30 seconds. Each flash is to have a duration of $5\frac{1}{2}$ seconds, and to be followed by an eclipse of $24\frac{1}{2}$ seconds. It is intended to use one De Meritens machine during clear weather, and two machines whenever the atmosphere is found to be so impaired for the transmission of light that the flashes are not reaching their intended range.

The defect here arose which is common to all electric flashing lights where a minimum and a maximum intensity of flash are adopted, viz. that the duration of the flashes of minimum and maximum intensity would vary in the ratio of the difference in the diameter of the carbons employed with one and two machines respectively, which in this case should be 50 mm. and 35 mm., this mean difference amounting to $36\frac{1}{2}$ per cent. nearly. It is evident that such a variation in the duration of flash would seriously impair the distinctive character of the signal.

It occurred to me, however, that, if carbons of a fluted cross-section were employed, the carbons for minimum and maximum intensity could be made of corresponding diameter, their sectional areas being proportioned to the minimum and maximum currents employed, and thus the flashes of minimum and maximum intensity would have exactly the same duration. As all carbons for electric arc lights are now made in moulds, I saw that such a form would not involve any more difficulty in manufacture than if made cylindrical, while there would be less liability of internal fracture occurring, as is often the case with large carbons in the process of drying and baking. Other advantages to be obtained with fluted carbons are: (1) a larger vertical angle of radiant light from the arc, and with a higher coefficient of intensity in consequence of the unobstructed radiance through the fluting at the points of each carbon; and (2) a steadier light is obtained owing to the localising of the current at the central portion of each carbon.

The result of many experimental trials with fluted carbons 50 mm. diameter have entirely confirmed my expectations. No crater is formed in either of the carbon points, and their form is all that can be desired for utilising fully the maximum light of the radiant arc. My experiments have not been sufficient to determine accurately the additional intensity of light obtained from the arc of a pair of the fluted carbons as compared with that from the arc of a pair of cylindrical carbons, but I am of opinion that the gain with fluted carbons is not less than ten per cent.

Geological Society, June 9.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—On the volcanic rocks of North-Eastern Fife, by James Durham, F.G.S., with an appendix by the President. After describing the general distribution of the volcanic rocks of Old Red Sandstone and Carboniferous age in the counties of Forfar and Fife, the author called attention to a fine section exhibited where the Ochil Hills terminate along the southern shore of the Firth of Tay. In immediate proximity to the Tay Bridge, a series of the later volcanic rocks, consisting of felstones, breccias, and ashy sandstones are found let down by faults in the midst of the older porphyrites (altered andesites) which cover so large an area in the district. The breccias contain enormous numbers of blocks of a red dacite (quartz-andesite), and inclosed in this rock angular fragments of a glassy rock, resembling a "pitchstone-porphyry," are found, everywhere, however, more or less converted into a white decomposition-product. The youngest igneous rocks of the district are the bosses and dykes of melaphyre (altered basalt and dolerite) which have been often so far removed by weathering as to leave open fissures. In the appendix three very interesting rocks were described in detail. The rock of the Northfield Quarry, which is shown to be the augite-andesite, has a large quantity of a glassy base with felted microlites, and contains large porphyritic crystals of a colourless augite. The rock of the Causewayhead Quarries is described as an enstatite-andesite; it has but little glassy base, being made up of lath-shaped felspar crystals (andesine), with prismatic crystals and grains of a slightly ferriferous enstatite; there are no porphyritic crystals, but the enstatite individuals are sometimes curiously aggregated. The red porphyritic rock from the breccias near the Tay Bridge was shown to be a mica-dacite, and the glassy rock associated with it to be the same material with a vitreous in place of a stony base. The glassy base exhibits very beautiful fluidal and perlitic structures. The crystals of first consolidation in this rock are oligoclase and biotite, often showing marks of injury in transport; those of the second consolidation appear to be orthoclase. In conclusion, the successive stages by which the andesitic rocks of the area were altered, so as to assume the characters distinctive of porphyrites, were fully discussed, as well as the change of the glassy rock into its white decomposition-product.—On some eruptive rocks from the neighbourhood of St. Minver, Cornwall, by Frank Rutley, F.G.S. The rocks described in this paper were derived from Cant Hill, opposite Padstow, and from a small quarry about half a mile from Cant Hill, near Carlion. At the former locality the volcanic rocks are much decomposed, but from their microscopic characters they may be regarded as altered glassy lavas of a more or less basic type. No unaltered pyroxene, amphibole, or olivine is to be detected in the specimens described, but there is a considerable amount of secondary matter which may include kaolin, serpentine, chlorite, palagonitic substances, &c. There is evidence of fluxion-structure in some of the sections; others are vesicular, and the vesicles are usually filled with siliceous or serpentinous matter. The relation of these lavas to the underlying Devonian slates was not ascertained. The rock occurring near Carlion contains numerous porphyritic crystals of augite in which the crystallisation is interrupted by the co-development of small felspar crystals, which appear, as a rule, to have been converted into felsitic matter. Ilmenite is also present in patches which indicate a similar interrupted crystallisation to that shown by the augite. The rock has the mineral constitution of an augite-andesite, but since it is a holocrystalline rock, exception would be taken by many petrologists to the employment of the term andesite. The lavas of Cant Hill were also probably of an andesitic character, so that, so far as original mineral constitution is concerned, there is some apparent justification for the mapping of both of these rocks as "greenstone" by the Geological Survey.—The Bagshot beds of the London Basin, by H. W. Monckton, F.G.S., and R. S. Herries, B.A., F.G.S. The authors stated that their object was to describe more fully the Lower Bagshot beds, and to disprove the view lately advanced by Mr. Irving that, in certain places, the Upper Bagshots overlap the Lower, and rest directly on the London Clay. They described or referred to a number of sections all round the main mass, beginning at St. Ann's Hill, Chertsey, where they considered that the mass of pebbles and associated greensands must be referred to the Middle Bagshot. The outliers near Bracknell and Wokingham were shown to consist of Lower and Middle Bagshot, which does not appear in the valley north of Wellington College. The Aldershot district was explained, and it was shown that the beds there resting on the London Clay were Lower and not Middle Bagshot, and the occurrence of fossils in the Upper Bagshot of that district was recorded. The conclusions that the authors came to were, that a well-marked pebble-bed was almost always present, marking the division between the Upper and Middle Bagshots, but that there were other pebble-beds of a less persistent character occurring both in the Middle and Lower Bagshots; that the Lower Bagshots generally consist of false-bedded sands with clay laminæ and no fossils except wood, whereas the Upper Bagshots are rarely false-bedded, and are characterised by the absence of clay bands and the presence of marine fossils; and that the Middle Bagshot is a well-marked series consisting of greensands and clays. They claimed, in conclusion, that there was no reason for disturbing the old reading of the district, and that there was no evidence of an overlap of the Lower Bagshots by the Upper.

Physical Society, June 12.—Dr. J. H. Gladstone, Vice-President, in the chair.—Dr. Samuel Rideal and Mr. E. C. Wellington were elected Members of the Society.—The following communications were read:—On an electric-light fire-damp indicator, by Messrs. Walter Emmott and William Ackroyd. The Royal Commission on Accidents in Mines point out in their recently-issued report, as a serious objection to the use of the electric light in mines, notwithstanding its many great advantages, that the light of an incandescent lamp, being produced within a vacuum, cannot admit of any device for the indication of fire-damp such as is given by the Davy, for example. The present apparatus is the outcome of an attempt to overcome this difficulty. It consists of two incandescent lamps, one with colourless and the other with red glass, and the circuit is so arranged that in an ordinary atmosphere the colourless lamp alone shines, but in fire-damp this goes out, and the red one is illuminated. This is effected in a simple manner by the motion of a mercury contact occupying the lower part of a curved tube, one end of which is open, and the other connected with a porous pot of unglazed porcelain, the motion of the mercury being due to the increased pressure in the porous pot occasioned by diffusion.—On a method of distinguishing rays of solar from those of terrestrial origin, by Prof. Cornu. It has been shown by M. Fizeau that, owing to the rotation of the sun upon its axis, there is a displacement of the spectral lines produced by solar absorption towards the red or towards the violet, according as to whether the light examined emanates from those parts of the sun which are receding from or approaching us. If, however, the lines are the result of absorption by the earth's atmosphere no such displacement should occur. It has been the aim of the author to make this principle the basis of a simple and instantaneous method of determining the origin of any given line. The displacement is very minute, amounting to about 1/150 of the distance between the D lines for rays in that part of the spectrum when the light is from the extremity of the solar equator, but it has been found quite sufficient. Observations have been made with a Rowland grating, the mean distance of the lines being ·00176 mm. An image of the sun is formed upon the slit of the spectroscope by a lens. By a slight oscillatory motion given to the lens by a lever from the hand, any part of the sun's image can be brought upon the slit. A heliostat sends the rays always in the same direction, and by a prism the image has its equator horizontal. To distinguish between a line of solar and one of terrestrial origin the line is brought near the vertical wire of the eye-piece, or, better still, one of those inevitable grains of dust which are always seen on the horizontal wire. The lever connected to the lens is then oscillated so as to bring alternately the two ends of the solar equator tangentially upon the slit. If the ray is of terrestrial origin it remains absolutely fixed, if it is solar it oscillates with the lever.—On a hyperbolagraph, by Mr. H. H. Cunynghame. It is not an unfrequent want to be able to find a rectangle of greatest or least area contained between a curve and rectangular co-ordinate axes. In several problems connected with motion and pressure in steam-engines this is useful, and even in political economy the graphic representation of monopoly curves depends on maxima and minima of this nature. For the solution of such problems it is often very useful to be able to describe rectangular hyperbolas, and the author has devised a machine to effect this. It depends on a mathematical property of the rectangular hyperbola, which he believes to be new, and which is as follows: From a fixed point let any line be drawn to meet a fixed line, and from the point of meeting draw the line perpendicular to the fixed line, and equal in length to the first line. The locus of the extremity of the second line is a rectangular hyperbola, or if from a fixed point O a line OP be drawn to meet a fixed line in a point P, and PQ be taken perpendicular to the fixed line, so that $OP + OQ$ be constant, then again the locus of Q is a rectangular hyperbola. In the machine the latter construction is mechanically and continuously carried out. A pencil, whose point corresponds in position to the point Q, slides along a rule which is carried across the paper always perpendicularly to the fixed line. A fine steel wire attached to the pencil passes over round a roller at P, and is then carried to and coiled round a similar one at O. The use of a steel wire is a special feature of the apparatus, and has a great advantage over string, which, owing to the facility with which it stretches, cannot give good results. The finest wire should be used: it unrolls from the one roller as much as it laps over the other, and its use may be extended to nearly all curve-drawing machines.—A voltaic cell with a solid electrolyte was exhibited by Mr. Shelford Bidwell. Its construction is as follows: upon a plate of copper is spread a layer of quite dry precipitated sulphide of copper; if on this a clean plate of silver is placed, and the cell joined up to a galvanometer, a slight deflection is observed due to the unavoidable presence of moisture. If, however, the silver plate be covered with a slight film of sulphide of silver, by pouring on it a solution of sulphur in bisulphide of carbon and evaporating the free sulphur by heat, and then placed with the prepared side down as before, a deflection is obtained far greater than, and in the opposite direction to, the former. The resistance of the cell was very great, but was enormously reduced by compression; the E.M.F. was about ·07 volt.

Mineralogical Society, May 21.—Prof. M. F. Heddle, M.D., F.R.S.E., in the chair.—The following papers were read:—On the nomenclature of the hydrocarbon compounds, with a suggestion of a new classification, by Andrew Taylor, F.C.S.—On new localities for diatomite, by Prof. W. Ivison Macadam.—On new localities for the mineral agalmatolite, with notes on its composition, by W. Hamilton Bell.—On a new locality for agalmatolite, with analysis, by Prof. W. Ivison Macadam.—The metallic ores of Chilé, by John F. Kerr, illustrated by a splendid collection of specimens.—On the chemical composition of the mineral found by Mr. Wallace at Loch Bhruithaich, Ross-shire, by Prof. W. Ivison Macadam.—Note on serpentine from Creag Mhòr Thollie, Loch Maree, by Prof. W. Ivison Macadam.—Notice of mica trap from Farley, near Beauly, by T. D. Wallace.—An excursion was made in the afternoon to the Spindle and Buddo Rocks, under the guidance of Prof. Heddle.

EDINBURGH

Royal Society, June 21.—Sheriff Forbes Irvine, Vice-President, in the chair.—Mr. Omond, of Ben Nevis Observatory, read a paper on the diurnal variation in the direction of the summer winds on Ben Nevis. These varying winds seem to be entirely local, and are caused by the heating of the one side of the mountain by the sun, while the other is cooled by radiation. The air consequently passes over the mountain from the hot to the cold side.—Mr. A. Buchan read a paper on the meteorology of Ben Nevis. He referred chiefly to three points:—(1) temperature-variation; (2) variation of barometric pressure; (3) wind-speed. As regards temperature, there is the usual morning minimum and afternoon maximum, which tend to be obliterated in the winter months. The barometer reads below average in the early morning, and above average in the afternoon. There is an afternoon minimum, which tends to disappear in summer. The wind-speed is below average during the night, and above average in the afternoon. The barometer reads low when the wind is high at the top of the mountain. Mr. Buchan pointed out that the great advantage of the Observatory is that simultaneous observations are made at the top of the mountain and at the foot, the station at the foot being on an incline sloping down to sea-level. If this latter condition is not satisfied, no reliance can be placed upon deductions from the results obtained as to the rate of diminution of temperature with height. The Observatory at Hong Kong is so conditioned, and the rate of diminution, as deduced from results obtained there, is 1° F. per 281 feet. From the Ben Nevis observations Mr. Buchan finds it to be 1° F. per 270 feet.—Mr. G. W. W. Barclay described some algoid lake-balls found in South Uist.—Dr. W. Hunter read a paper on the duration of life of the red blood-corpuscles, as ascertained by transfusion. Three weeks is the average period given by his experiments. When there is no devitalising action in the corpuscles by the method of observation employed, it is probably from three to four weeks.

PARIS

Academy of Sciences, June 21.—M. Jurien de la Gravière, President, in the chair.—Improvement of the bar at the mouth of the Senegal River, by M. Bouquet de la Grye. Having studied the question on the spot during the year 1885, the author proposes some simple measures by which the dangerous effects of the bar might be obviated and the navigation of the Senegal waters greatly improved.—On some double phosphates of thorium and potassium or of zirconium and potassium, by MM. L. Troost and L. Ouvrard. By preparing a certain number of phosphates of thorium and the corresponding compounds of zirconium by the dry process, the authors have endeavoured to verify the analogy pointed out by several observers between thorine and zircon. They find that the metaphosphate and the pyrophosphate of potassa yield with thorine and zircon double phosphates which have analogous compositions, but are not isomorphous. The orthophosphate of potassa gives double phosphates which have different compositions; nor is there any isomorphism between thorine and zircon obtained by calcination of the double phosphates at very high temperatures.—On the ammonia present in the ground, by MM. Berthelot and André. In reply to M. Schlœsing's last paper the authors claim to have made good their original statement that the ammonia present in the ground should be analysed without any dessication or previous treatment. They also join issue on various incidental points raised by M. Schlœsing himself during the controversy.—On the extension to a class of analogous forms of the theorem relative to a number of asyzygetic invariants of a given type, by Prof. Sylvester.—On the discovery of a new metal, austrium, announced by M. Ed. Linnemann in the *Monatshefte für Chemie* for April 1886, by M. Lecoq de Boisbaudran. From the description given of its chemical properties, its electric spectrum, and the process of its extraction from the orthite of Arendal, the author thinks that this substance is very probably gallium, a small quantity of which might easily be contained in orthite. The two rays of austrium approximately measured by M Linnemann are $\lambda = 403\cdot0$ and $416\cdot5$, those of gallium being $403\cdot2$ and $417\cdot05$. For both the ray 417 is the strongest.—Remarks accompanying the presentation of three volumes of the *Annales du Bureau central météorologique* for 1884, by M. Mascart. Attention is drawn especially to M. Fron's paper on the distribution of thunderstorms in France during the year 1883; to M. Moureaux' memoirs on the methods employed at the Parc Saint Maur Observatory for the study of terrestrial magnetism; and to M. Teisserenc de Bort's paper on the distribution of cloudiness over the surface of the globe.—Observations of Brooks's Comet III. (*c*, 1886), made at the Observatory of Algiers (0·50m. telescope), by M. Ch. Trépied.—Developments in trigonometrical series of certain functions verifying the equation of the potential $\Delta F = 0$, by M. Appell.—Note on some new groups of surfaces of two dimensions in spaces of n-dimensions, by M. Giovanni Bordiga.—Observations on M. Ledieu's note relative to the roll of vessels at sea, by M. de Bussy.—On the vapours emitted by a mixture of volatile substances, by M. P. Duhem. It is shown that the partial pressure of the vapour emitted by each of the two fluids mixed together is less than the tension of saturated vapour of the same fluid taken in the pure state.—Dynamics of the molecule of water: velocity of the propagation of sound; compressibility; heat of fusion of ice; specific heat of ice, by M. M. Langlois.—Calorimetric study of iron at high temperatures, by M. Pionchon. A detailed examination is made of the characteristic modifications experienced by iron at a temperature of about 700° through the extremely rapid absorption of heat in a comparatively slight interval of temperatures.—Conditions under which is realised the maximum of useful work in an electric distribution, by M. Vaschy.—Note on atmospheric refraction, by MM. J. Chappuis and Ch. Rivière. This phenomenon is here studied by a method based on the employment of Jamin's interferential refractometer.—New facts bearing on the phenomenon of the apparent oscillation of the stars, by M. Aug. Charpentier. Several observations are made, tending to show that the phenomenon is of a purely subjective character, due especially to the unequal fatigue of the muscles of the eye, or rather to their innervation.—On the presence of a new element in samarskite, by Mr. W. Crookes. The already described abnormal orange band $\lambda = 609 = \frac{1}{\lambda^2} 2693$, which the author supposed due to a mixture of the two earths yttrium and samarium, he now finds cannot be due to either of these, the only probable alternative being that it belongs to some new element. Until it can be separated from the asssociated substances and its chief properties determined, he proposes to name it S*a*, the initial letter S indicating its samarskite origin.—On the dissociation of the hydrates of the sulphate of copper, by M. H. Lescœur.—Action of the acids and bases on emetic solutions, by M. Guntz.—Action of water and of ammonia on the chloride of methylene, by M. G. André.—Some new properties of cyanated camphor, by M. Alb. Haller.—A contribution to the study of the alkaloids, by M. Œchsner de Coninck. The author applies the method of MM. Hoogewerf and Van Dorp to the treatment of some iodides of pyridic ammonium—isomethylate of pyridine, C_5H_5N,CH_3I, and iodethylate of pyridine, C_5H_5N,C_2H_5I.—On the normal dinitriles

$$CN—(CH_2)_n—CN,$$

by M. L. Henry.—Chemical researches on the products of the eruption of Mount Etna during the months of May and June 1886, by M. L. Ricciardi. The sands collected at Cibali were of a blackish colour, consisting mostly of amorphous detritus mixed with crystalline fragments of labradorite, olivine, and pyroxene readily affected by the magnet. The ashes ejected on May 28–29 present similar characteristics with a larger quantity of salts soluble in water.—Volumetric analysis of the sulphur in the sulphides decomposable by hydrochloric or sulphuric acid, by M. Fr. Weil.—Researches on the growth of beetroot, by M. Aimé Girard. This paper deals especially with the stalk, which during growth consists of a tissue, in the elementary organs of which water and sugar, forming a constant quantity, are mutually replaced according to the circumstances.—Researches on the structure of the scorpion's brain, by M. G. Saint-Remy.—On the structure of the germ vesicle in *Siphonostoma diplochætos*, Otto, by M. Et. Jourdan.—On the post-embryonic evolution of the vitelline sac in birds, by MM. Charbonnel-Salle and Phisalix.—On the vascular system of *Spatangus purpureus*, by M. H. Prouho.—On the glands of insects: a pretended "new type of elastic tissue," by M. J. Gazagnaire. The paper deals especially with the unicellular glands first described by Meckel in 1846, and afterwards studied by Stein, Sirodot, Leydig, and others. To these are referable M. H. Viallanes' pretended "elastic cellules."—On some histological peculiarities of the digestive tube in the simple Ascidians, and especially the Cynthiæ, by M. L. Roule.—On the geological constitution of the Pyrenees: the Triassic system, by M. E. Jacquot. The author's investigations lead to the conclusion that along the French slope, from the banks of the Nive to the Teck valley, the Triassic formation presents a uniform composition, recalling that of the ranges in Franche-Comté, Provence, and Lorraine.

BERLIN

Physical Society, May 21.—Dr. König spoke on the modern attempts towards laying down an unexceptionable basis of mechanics. Among the axioms of mechanics the law of inertia set up by Newton was the most important, but neither the conceptions of time, which lay at the basis of the idea of uniformity, nor the conception of the straight line, were precisely definable without further assumptions. A whole series of attempts had been made to fix these fundamental conceptions, attempts which the speaker briefly sketched. He came to the conclusion that as standard of time not the movement of translation, which could never be absolutely measured, but the movement of rotation must be recognised. The movement of rotation was perceptible in itself, namely, through the oblateness of the rotating ball. With regard to the straight line, that is with regard to our co-ordinate system in space, the speaker accepted the ideas set forth last year by Herr Lange of Leipzig, who started with a notion developed by Prof. James Thomson of Glasgow. Dr. König gave a graphic representation of the idea which had been only mathematically developed and established. According to this representation it was possible, when three points described in a particular space any paths whatsoever, to follow with a co-ordinate system these movements in such a manner that all three points moved rectilinearly. Experience taught that when three points described straight lines to such a co-ordinate system, each fourth, fifth, and so on, did it as well. Thus in the movements of rotation, and in the mobile co-ordinate system, unexceptionable bases of mechanics might be found whereupon to raise a superstructure, just as mathematics was built up on its axioms.

BOOKS AND PAMPHLETS RECEIVED

"Official Guide to the Museums of Economic Botany, Kew," No. 1, "Dicotyledons and Gymnosperms," 2nd edition (Eyre and Spottiswoode).—"Quarterly Journal of Microscopical Science." June (Churchill).—"*Challenger* Reports," vol. xiv. "Zoology."—"Hygiene of the Vocal Organs," by Dr. M. Mackenzie (Macmillan).—"Disorders of Digestion; their Consequences and Treatment," by Dr. T. L. Brunton (Macmillan).—"Photo-Micrography," by I. J. Jennings (Piper and Carter).—"Birds on the British List," by Rev. G. Smart (R. H. Porter).—"Proceedings of the Linnean Society of New South Wales," vol. x. part 4 (Cunninghame, Sydney).—"Proceedings of the Physical Society of Moscow," tome viii. No. 2.—"Bourne's Handy Assurance Directory, 1886" (Bourne, Liverpool).—"Journal of Anatomy and Physiology," July (Williams and Norgate).—"General Index to the Year-Book of Pharmacy for the Years 1864 to 1885" (Churchill).—"The Great and Growing Question of Vaccination" (E. W. Allen).—"Studies from the Biological Laboratory, Johns Hopkins University," vol. iii. No. 7.

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