THURSDAY, SEPTEMBER 29, 1881

THE STRUGGLE OF PARTS IN THE ORGANISM

Der Kampf der Theile im Organismus: ein Beitrag zur Vervollständigung der mechanischen Zweckmässigkeitslehre. Von Dr. Wilhelm Roux, Privatdocent und Assistent am Anatomischen Institut zu Breslau. (Leipzig: Wilhelm Engelmann, 1881.)

SINCE the first dawn of methodical inquiry one of the largest and most important problems that has always been presented to scientific thought is the explanation of the endless number and complex variety of those apparently purposive adaptations of structures to functions which are everywhere to be met with in organic nature. Until within the last few years the solution of this problem was all but universally sought in the hypothesis of a designing mind, and as no other cause had been suggested as adequate to produce such a multitude of seemingly teleological effects, it became a habit of philosophical thinking to regard these effects as evidences of a creating intelligence. And although the scientific instincts of an individual here and there pointed towards the belief that in some unaccountable manner the facts were due to physical as distinguished from metaphysical causes, the scientific instincts which pointed in this direction were unable to justify themselves on grounds of reason, inasmuch as they were unable to suggest any non-mental principle which could reasonably be taken to explain a class of phenomena bearing so suggestively the appearance of a mental origin. The tide of thought in this matter therefore rose without interruption or perceptible hindrance in the direction of supernaturalism, until it attained its highest level in the "Argument from Design" as elaborated by the natural theologians of the past generation. Then with a suddenness only less surprising than its completeness the end came; the fountains of this great deep were broken up by the power of one man, and never in the history of thought has a change been effected of a comparable magnitude or importance.

But although the theory of natural selection as conceived and elaborated by Mr. Darwin so completely subverted the foundations of what may be termed a scientific teleology, it soon became apparent that natural selection alone was not adequate to explain all the facts of adaptation that are met with in organic nature. Not to enter upon the question, which we can only hope that future generations may be able to answer, as to how far natural selection alone, or unassisted by any other principle, is competent to produce changes of specific type—how far, in other words, we are to attribute the evolution of species to the uncompounded operation of the survival of the fittest, and how far to the probable operation of other and unknown factors—not to enter upon this question, it is enough to observe that many cases of adaptation which occur in the parts of individual organisms cannot possibly be explained by the theory of natural selection as this is applied to explain cases of adaptation which are presented by specific types. Thus, to take the most simple illustration, the effects of use and of disuse in increasing or diminishing the functional utility of an organ in obvious adaptation to the requirements of the individual organism—these effects clearly cannot be attributed to survival of the fittest organisms. Similarly in the morbid processes of disease there is frequently observed "an effort of nature" to throw off the affected part, or otherwise to effect a spontaneous cure. These and other considerations of the same kind have led all the more thoughtful evolutionists—including Mr. Darwin himself—to conclude that over and above the great principle of natural selection, operating from without the organism and therefore called by Mr. Herbert Spencer "indirect equilibration," there must be other principles of an adaptive character at work within the organism itself, and therefore collectively called by Mr. Spencer the principles of "direct equilibration." And it is evident that one of the most important problems now presented to evolutionists is that of ascertaining what are these principles of direct equilibration. The work before us is an interesting effort in this direction.

The idea which Dr. Roux elaborates at much length is that the principle of the struggle for existence and consequent survival of the fittest is in active operation, not only as between individuals of the same or different species, but also between the constituent parts of the same individual. As all the parts of an organism receive their nourishment from a common and limited supply, there necessarily arises among them a competition for food, so that, for instance, in any cellular structure the most vigorous cells will survive by starving out the less vigorous, just as is the case with organisms living in an area of limited food-supply. Also, and especially after the period of full growth of the organism has been attained, the mutual pressure exerted by neighbouring cells must give rise to a further competition—a struggle for room or space wherein to develop—and here again it will be the most favoured elements that will be successful in attaining a vigorous maturity. In these and in several other minor respects which we need not wait to mention, Dr. Roux maintains that all the organs, cells, and even molecular groupings of an organism are so situated as to be constantly under the evolutionary influence of the struggle for existence. If such is granted to be the case, the author proceeds to show how a foundation is supplied for explaining all or many cases of "direct equilibration," or, as he terms it, "capacity of functional adaptation." For this capacity amounts merely to an increase or diminution of the functional power of a part under the influence of an increase or diminution of stimulus, using the latter term in its most comprehensive signification as including any change of conditions acting from without. (This, at least, seems to be the sense in which Dr. Roux uses the term, as he applies it indifferently to an excitation of nerve or muscle, increase of traction upon a bone, blood-pressure in an artery, &c.) But if a stimulus means a change of conditions, it means, when frequently repeated, a change of the physiological environment of the structure affected, and therefore, if the constituent parts of this structure are subject among themselves to a keen struggle for existence, those parts which are best adapted to the change will survive, while the others will succumb, with the ultimate effect of altering the form or function of the structure so as to meet the new circumstances of stimulation.

Such in the most general terms is the doctrine advocated in "Der Kampf der Theile im Organismus." Perhaps the most striking feature in the detailed exposition which the author gives of the doctrine is his ignorance of the fact that the doctrine is not original. His work is pervaded by expressions of the importance which he attaches to his idea as that of a new light shining in a dark place, and he is surprised that in the domain of physiology the thoughts of Darwin should not have been earlier applied. But in this country, at all events, the idea is far from being a novel one. Not to mention writers of less repute, Mr. Spencer has meditated deeply upon the causes of "direct equilibration," and his works are over-charged with analogies drawn between the organism physiological and the organism social—analogies which include the struggle for existence and survival of the fittest in all their ramifications. Nevertheless, although Dr. Roux seems strangely ignorant of the philosophy of evolution as taught by Mr. Spencer, his work is of value in pursuing this branch of the subject into greater detail, and with more extensive knowledge of physiology, than has been hitherto done. The topic is a deeply interesting one, and we therefore welcome this attempt at its elucidation. We must, however, observe that Dr. Roux, in the ardour of speculation, is too prone to endow a "muss sein" with the value of an inductive verification; and we must emphatically express our dissent from him wherever he appears to insinuate that the doctrine of natural selection in the domain of physiology has evidence in its favour at all comparable with that which belongs to it in the domain of zoology and botany. GEORGE J. ROMANES

OUR BOOK SHELF

Pflanzenphysiologie: ein Handbuch des Stoffwechsels und Kraftwechsels in der Pflanze. Von Dr. W. Pfeffer, Professor an der Universität Tübingen. Band I. "Stoffwechsel." (Leipzig: Engelmann, 1881.)

IN treating of the Physiology of Plants, Prof. Pfeffer very naturally divides his subject into two parts, the first being "Stoffwechsel," or metabolism, the second the concomitant "Kraftwechsel," that is, the conversions of latent into kinetic energy and *vice versâ* which are involved in the metabolic processes. The volume now before us treats of the "Stoffwechsel," and it does so in a very thorough and satisfactory manner. In the first place there is evidence in the work of a very complete acquaintance with the extensive literature of the subject, and further, of a critical power of recognising and bringing into prominence those observations which are worthy of being incorporated in the canon of physiological knowledge. The general treatment, too, of the subject is clear and logical, though it suffers from a fault which is not uncommon with German authors, namely this, that the main line of thought becomes here and there obscured by the cloud of detail with which it is enveloped. Still the book is a mine of information for original workers, and a trustworthy guide for advanced students. It is not too much to say that it is the best work in existence on the subject. If the second volume is as good as the first, Prof. Pfeffer will indeed have to be congratulated.

SYDNEY H. VINES

The Norwegian North Atlantic Expedition, 1876-1878. III. Zoology. (Christiania, 1881.)

PART III. of the account of the animals obtained during the above expedition is by the well-known naturalists, D. C. Danielssen and J. Koren, and treats of the group of the Gephyrea. It is illustrated by six plates and one map. Of the ten genera and the sixteen species collected during the expedition four of the genera and seven of the species prove to have been undescribed, and a new family is formed for the remarkable new genus Epithetosoma. This genus differs in many respects from any known genus of the Gephyrea; most notably so by reason of the fissured opening through which the sea water gains access to the perivisceral cavity. The analogue of this respiratory fissure is probably not to be found in the class, but the general organisation of this new form is still truly Gephyrean. Unfortunately but two examples of this interesting form were dredged up, and even these were not well preserved. They were found in sandy clay at a depth of 870 fathoms, in the cold area. In concluding the memoir the authors remark that the two groups into which the class Gephyrea is subdivided, viz. *G. inermia* and *G. armata*, can hardly be regarded as satisfactory. Of several new forms which they describe, and which by reason of their anatomical structure they refer to the second subdivision, none are furnished with the armature on which that subdivision is based. Had therefore the systematic classification been rigorously applied, these would have been referred to the first subdivision, one with which they have but little in common, compared to the striking resemblance they bear to those forms comprised in the other. A list of all the species met with and their principal synonyms are appended.

A Manual of Injurious Insects, with Methods of Prevention and Remedy for their Attacks to Food Crops, Forest Trees, and Fruits, and with Short Introduction to Entomology. By Eleanor A. Ormerod, F.M.S. Pp. 1-323. 8vo. (London: W. Sonnenschein and Allen; Edinburgh: J. Menzies and Co., 1881.)

THE authoress of this book is well known as an enthusiast in the department of Economic Entomology, and may thoroughly be congratulated upon having produced a work that cannot fail in many ways to be useful to the class of readers for whose instruction and profit it is intended. In many respects it is based upon Curtis's familiar (but somewhat obsolete) "Farm Insects," and many of the usually excellent illustrations are counterparts of those that appeared in that work; many others were originally from the faithful pencil of Prof. Westwood: in both cases the old volumes of the *Gardeners' Chronicle* have furnished contributions; a few are from other sources. As in Curtis's work the subject is dealt with according to the plants attacked, not according to the attacking insects, a plan to be much commended in such a work. In each case a short description of the insect and of its methods of attack precede the consideration of Prevention and Remedies. Naturally much is compiled from previous writers; much information given is the result of records obtained from the many willing assistants of the authoress; much is original from her own observations. It is not our duty to enter into an examination of the suggested "remedies"; we vastly prefer to look with more favour upon the means of prevention, and are glad to see that generally sound advice in the way of scientific cultivation is given throughout. Nor are the meteorological conditions overlooked: we can modify many things—we cannot rule the elements; and in very bad seasons we fear our farmers and gardeners must be content to "pocket the loss" occasioned by insect ravages on crops the constitutions of which have been already ruined by atmospheric conditions. In a few cases subjects appear to have been introduced for the sake of effect. For instance, we doubt if any farmer in the kingdom is one penny the worse for the occasional presence in his potato-fields of the larva of the Death's Head Moth; on the other hand many bee-keepers could tell a different tale from the ravages of the moth itself in their hives. The Colorado beetle, of course, has "honourable mention";

but we are rather sorry to find the authoress enthusiastic at the passing of the "Injurious Insects" Act of Parliament, which we prefer to consider the outcome of a scare furthered by speculators. All we can say for the "Introduction to Entomology" is that it will possibly serve to give the class for whom it is intended sounder ideas on the subject than generally prevail with them; the Glossary at the end is too short to be of much service.

Zinn: eine geologisch-montanistisch-historische Monographie. Von E. Reyer. 8vo. (Berlin: Reimer, 1881.)

IN this monograph, as is indicated by the agglutinative adjective on the title-page, the author has collected the results of his studies on the technological history of the metal tin under the threefold head of geology, mining, and history; or rather the reader may do so for himself from the material which is presented in an abrupt fashion without either preface or index. The first part of the volume is devoted to descriptions of the tin-producing districts of Saxony and Bohemia, the geological features of each district being first considered, then its history as derived from the local archives and notices in published chronicles, the whole of the facts concerning production being summed up in a chronicle of tin mining in Bohemia and Saxony, with tabular statements and diagrams of the production from the earliest period for which records are obtainable, about the year 1400, down to the present time. From these we gather that the total production of both countries, which was about 100 tons in the year 1400, reached in 1500 a maximum of about 1000 tons, since which time it has steadily declined, the produce at intervals of fifty years varying from 75 to 125 tons annually. At the present time the production is practically confined to Altenberg in Saxony, where about 50 tons are obtained from the treatment of a staminiferous granite containing about 8 lbs. of tin ore per ton. In subsequent sections of the volume the productions of Cornwall, Banca, and Australia are treated in a similar manner; a descriptive sketch of the geology of each locality being given in each case, followed by a chronicle of events and prices. These being mainly compiled from well-known sources, such as De la Bêche's "Cornwall and Devon," Von Diest's "Banca," the reports issued by the Australian and Tasmanian Colonial Governments, &c., present less of novelty than the first part, which contains much original matter derived from the author's own investigations; but the skilful manner in which the information is presented is likely to render the volume very useful to those interested in the subject. An unnecessary difficulty has been introduced by the adoption of the new-fashioned phonetic system of spelling which has latterly become prevalent in Berlin, and will doubtless prove a puzzle to many readers.

H. B.

LETTERS TO THE EDITOR

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

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

The Progress of Meteor-spectroscopy

IN the profound and eloquent review of the progress of British and other discoveries in science during the last half century given in the Opening Address to the British Association at its recent Jubilee Meeting in York by its President, Sir John Lubbock, I am credited (NATURE, vol. xxiv. p. 409) with some meteor-spectrum observations which, while they certainly unfold some of the most important results arrived at in meteor-spectroscopy since its commencement in the year 1866, yet owe their recognition as scientific discoveries of some material weight and real consequence, to quite a different author.

Although with the first use of a meteor-spectroscope I recognised in the persistent streaks of the August Perseïds of that year numerous examples of the yellow-sodium line, yet no proof was furnished by the slender spectroscopic power employed, of the existence in the meteor-streaks of any other substance. It was by a Hungarian astronomer, von Konkoly, that the presence of "lithium, potassium, and other substances" in the streaks of shooting-stars was afterwards discovered; and of some of these substances Herr von Konkoly obtained such repeated and well-verified observations, that the identification of their spectroscopic presence in certain meteor-streaks may be regarded as satisfactorily established.

The instruments made by Mr. Browning for the British Association Meteor-Committee in the year just mentioned were intended to be used in studying the spectra of the November Leonids, whose magnificent display took place as expected, but was of such short duration that nothing of great importance was, unfortunately, elicited as regards their spectra. A more successful trial of the instruments had however been made previously on the 9th–11th of August of the same year,[1] and abundant evidence was then obtained of the existence of two classes of meteor-streaks, both equally persistent, one of them affording a continuous spectrum only, like what hot sparks or train-matter would produce; the other more or less charged with, and sometimes consisting entirely of the yellow sodium-line.

No distinct evidence was obtained, however, in that first year's experimental trials of the occurrence in meteor-streaks of any other elementary spectrum-lines besides the solitary sodium one. The spectra of the nuclei were continuous, the brightest ones showing all the prismatic colours in perfection; and only one or two at the same time allowed some traceable evidence of sodium to be detected in their light. But a few of the green "Leonid" streaks were noticed in November to be, to all appearance, monochromatic, or quite undispersed by vision through the refracting prisms; from which we may at least very probably infer (by later discoveries with the meteor-spectroscope) that the prominent green line of magnesium forms the principal constituent element of their greenish light.

Meteor-spectroscopes of a more efficient kind were afterwards devised and produced by Mr. Browning. But they remained, as far as I am aware, without any successful application until the nights of July 25th and 26, 1873, when the spectra of three streak-leaving shooting-stars were observed through one of them by the enthusiastic astronomer of O'Gyalla, near Komorn in Hungary, Herr von Konkoly.[2] The streaks of the first two meteors seen showed only the sodium-line; but in that of the third, which was an emerald-green meteor, the green spectral line of magnesium (Fraunhofer's solar line *b*) was plainly visible in addition to the yellow sodium-line. The spectra of the nuclei were continuous, only the green region of the spectrum in that of the last meteor being of unusual brightness.

On the morning of the 13th of October in the same year Herr von Konkoly again observed with Browning's meteor-spectroscope the long-enduring streak of a large fireball, which was visible in the north-east at O'Gyalla. It exhibited the yellow sodium-line and the green line of magnesium very finely, besides other spectral lines in the red and green. Examining these latter lines closely with a star-spectroscope attached to an equatorial telescope, Herr von Konkoly succeeded in identifying them by direct comparison with the lines in an electric Geissler-tube of marsh-gas.[3] They were visible in the star-spectroscope for eleven minutes; after which the sodium and magnesium lines still continued to be very brightly observable through the meteor-spectroscope; and the streak faded out of sight in a comet-seeker, at last, twenty-five minutes after it was first observed.

In July and August, 1879,[4] and in August, 1880,[5] Herr von Konkoly observed spectra of the nuclei and streaks of many Perseïds and other meteors with the Browning's meteor-spectroscope. The yellow sodium-line was conspicuous in most of the streak-spectra, and adjoining it there were seen in many cases the red line of lithium and another more distant red line supposed to be that of potassium; but the violet line of potassium,

[1] *The Intellectual Observer*, vol. x. pp. 38 and (with a coloured plate) 61; August and October, 1866.

[2] *Monthly Notices of the Royal Astronomical Society*, vol. xxxiii. (1872-73), p. 575.

[3] *Monthly Notices of the Royal Astronomical Society*, vol xxxiv. (1873-74), p. 82. The description "lightning-gas" there given of the tube is, as Herr von Konkoly afterwards informed me, a misprint for "lighting" or "coal-gas," "mit welchem die Strassen beleuchtet sind."

[4] *The Observatory*, vol. iii. p. 157.

[5] Ibid., p. 577.

probably owing to its relative weakness in comparison with the red one, could not be observed. Green and blue lines of other elements were also noticed, among which the most frequently conspicuous one, next to the yellow sodium-line, was, again, the green line of magnesium.

On August 13, 1879, the nucleus of an emerald-green bolide, as bright as Jupiter, produced a splendid continuous spectrum from red to violet, exhibiting first a bright sodium-line, and immediately afterwards the green magnesium-line also, and some others, supposed to be those of copper, with two faint red lines. A similar bolide on August 9, 1880, showed on the continuous spectrum of its nucleus, besides the sodium-line very bright, those of lithium distinctly, and many metallic lines in the green and blue portions of the spectrum.

This occurrence of carbon, magnesium, and other spectral lines (possibly of iron) in the vapour-streaks of shooting-stars and fireballs, establishes a more certain and unequivocal resemblance between their chemical compositions and those of solid meteorites, than does the exhibition of the sodium-line, which, as Herr von Konkoly observes, may possibly be due to the original presence of saline particles in the air itself. But its extreme brightness in some, and total absence in other meteor-streaks, seems yet rather difficult to account for on that supposition. On the other hand the detection of carbon, while it agrees with the element's occurrence in siderites and carbonaceous aërolites, reminds us also of the abundant proofs which Dr. Huggins and other spectroscopic observers have obtained of the same element's prevalence in comets. And indeed the prolonged luminosity of meteor-streaks, with their complex gaseous spectra proceeding for long courses of time from an exceedingly attenuated atmosphere, is itself a physical riddle whose explanation as a mere question of radiation can scarcely be very different from what is demanded by the phenomenon of self-luminosity in the known gaseous nebulæ and in the envelopes of comets.

Of Dr. Huggins' applications of sidereal spectroscopy to neubulæ and comets, it may be mentioned that the extremely eventful discoveries are not individually named and noticed among the many high encomiums rightly bestowed upon that refined use of the spectroscope, in the opening address. But the results therefrom obtained were yet fully as revolutionising as regards the prevailing theories of those bodies, and of the general plan of construction of the sidereal heavens, as some of the spectroscopic discoveries described in the fifty-years' retrospect were (as is there lucidly related) thoroughly subversive of the formerly existing views of the internal physical condition of the sun.

If I have here ventured to disown, and to disclaim for myself some of the major accomplishments of meteor-spectroscopy by showing them to be the results of later, independent, and much more perfect observations, it is because, in comparison with the very significant amplification which those later observations have effected in the subject, the easy recognition of the presence of sodium in meteor-streaks can only claim to be regarded as a slight and inconsiderable first-adventure in a province of spectrum analysis, the additions and improvements subsequently made in which have been attended with much more remarkable success.

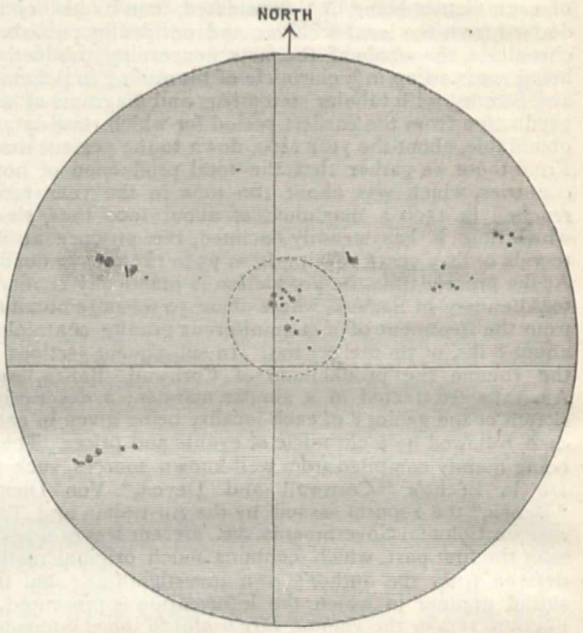
In the wide and accurate survey of the admirable opening discourse, which strays with truly lifelike fidelity over all the broad domains, the well-won fields and gallantly-scaled citadels of modern scientific knowledge, I shall, I trust, be pardoned if, in a matter of very little estimation by itself, I thus attempt to remove and banish from the eulogies of the address a small and unobtrusive and apparently unconscious excrescence of the otherwise harmless and innocent transgression, *magnis componere parva*.

A. S. HERSCHEL

Collingwood, September 12

Sun-Spots

RECORDS concerning phenomena are considerably enhanced in value if they include accurate determinations of the *times* of occurrence. This appears specially applicable to solar phenomena, and particularly to sun-spots, of which there must be many thousands of exact delineations without precise record of the times when the spots first appeared on the visible surface of the sun. No doubt there are several reasons to account for this unavoidable absence of valuable information; amongst others the intense brightness and heat of the sun make it an exceedingly disagreeable object for protracted telescopic inspection; nor yet are we in a position at present to photograph it continuously, so that we are necessarily content to compare photographs taken at intervals of perhaps many hours, and to assume, or at any rate not to dispute, that events of great importance have not occurred in the intervals. This is the more to be regretted because a knowledge of solar events is comparatively of little importance unless it helps us to ascertain what influence those events exercise on the earth and its inhabitants; and it is obvious that in comparing solar and terrestrial phenomena the times of occurrences are of essential importance, if only to avoid ascribing an undue effect to a given cause. It thus follows that even an approximate time of the appearance of sun-spots is not without value. On these grounds, as well as on the score of magnitude, I communicate the following particulars of a recent appearance, or outburst, of sun-spots, which occurred within certain moderate limits of time. I premise briefly that a photoheliograph is in daily use at the Trigonometrical Survey Office, Dehra Doon, India, of which I have executive charge. At present the instrument yields but a 4-inch negative, which is merely a microscopic delineation of 1¼ million millions square miles of solar surface; however, as surely



Tracing from sun negative taken at Dehra Observatory, Great Trigonometrical Survey of India. Latitude 30° 19′ 29″ N.; Longitude 78° 5′ 42″ E. Height above sea 2232 feet, on July 25, 1881, at 4.47 p.m. local apparent time. Spots visible in previous negative taken on the same day at 3.58 p.m. are coloured black; and the new spots which appeared between 4 and 5 p.m. are surrounded by a dotted circle.

as the sun shines, so surely are at least two negatives taken of it daily. Interruptions, even in a land of sunshine like this, sometimes occur; notably at the bursting of the monsoons, which occurred here last month (July), when the photographer was compelled to take the sun whenever visible, rather than not take him at all. Under this choice of alternations the first negative (or say N_1) on July 25, 1881, was taken at 3.58 p.m. of local apparent time; it exhibited several sun-spots, as is now usual, and of which therefore little need be said, since solar observers are well aware that the sun has for some months past resumed a state of considerable energy in respect to development of features; the second negative, or N_2, was taken at 4.47 p.m. On comparing N_1 and N_2 it was at once seen that in the interval of 49m. a considerable group of spots had appeared in the neighbourhood of the sun's centre. It is exceedingly difficult to exhibit an exact delineation of spots when the negative is on so minute a scale; I however inclose a silver print, as well as a hand-tracing of N_2, from which the position and magnitude of the group, *i.e.* the new group, may be nearly inferred. This new group consists of sixteen spots, of which no individual spot is notably large, but there is this peculiarity about them all, that they exhibit hardly any penumbra, but consist almost entirely of well-defined umbra; what penumbra appears, is

confined chiefly to two spots, where it is seen only to the south-east; imagine a round, straight hole bored through a stratum of sand sufficiently adhesive for the sides to remain erect for a time, and after this suppose that the sand begins to fall inwards, creating a partial cone around to the south-east side; this is the sort of progress that these two spots convey. As to magnitude, the spots are scattered over an area of some 6000 millions of square miles; while the collective area of the spots themselves is about 630 millions of square miles, or, say, six times the area presented by the earth to the sun. Remembering that of solar change "a little goes a long way," so far as we are concerned, who shall say that changes of this magnitude are inappreciable on the earth, however ineffectual the instruments we can now command may be able to measure them? But was this sudden change inappreciable? that is now the question. Unhappily the sun remained invisible till July 30, when two negatives were taken, *i.e.* after an interval of just five days; so far as solar rotation could effect, the so-called new group of N_2 should have been visible not far from the sun's western edge; but the entire group had vanished, leaving no trace behind. In the interim of five days two new spots had come out; of *one* of these I may add that the umbra is about 200 millions of square miles, and the penumbra some 700 millions, presenting in all a single feature of more than 900 millions of square miles, or say nine times the area exhibited by the earth to a distant spectator. This ends the purport of my letter. But I cannot help adding that I believe the bright solar features or faculæ will eventually prove to be more effective exponents than the dark features or spots; as a matter of fact, faculæ commonly appear in abundance, covering considerable areas and branching out from one another like coral reefs; and it is a mistake to suppose that faculæ exist only in the vicinity of spots; the former may abound where the latter are quite absent, not only in a 4-inch negative, but in a very fair 5-inch equatorial. But I suppose the world will be better informed some day. Meanwhile, surely the sun is worthy of more earnest attention, not only from points of attack already so ably occupied, but from others none the less important, though at present greatly neglected: need I name solar radiation and photography? Physicians are alarmed for the safety of our bodies on detection of even a trifling change in temperature; but what do we know of fluctuations in the source of all terrestrial heat, though it be measurable with an actinometer? Again, land surveys are often made on huge scales; but for the solar survey of 1¼ million millions of square miles, what is our largest delineation, and at how many spots round the world is the required daily record made? If a survey of London pays, depend on it surveys of the sun will pay all nations infinitely better.

J. B. N. HENNESSEY

India, North-West Provinces, Mussooree, August 5

Proneomenia sluiteri, Hubrecht

IN the report of the Proceedings of the Biological Section of the British Association which appeared in NATURE, vol. xxiv. p. 501, there is a slight mistake in the notice of my friend Dr. Hubrecht's paper on *Proneomenia*. This interesting mollusc is erroneously described as "one of the valuable finds of the *Challenger* Expedition." So far as I am aware, neither *Proneomenia* nor either of the other two genera of the *Solenogastres* (*Neomenia*, *Chætoderma*) was obtained by the *Challenger*. The only two specimens of *Proneomenia* which are known to science as yet were dredged by the Dutch Arctic Expedition of 1878 (or 1879), at depths of 110 and 160 fathoms in the Barents Sea. It was not obtained by the *Wilhelm Barents* in 1880, but we may hope that the dredgings of this season have been more productive, for Dr. Hubrecht informs me that 1881 has been a very bad ice year, and that the *Wilhelm Barents* has not succeeded in penetrating so far north as she has done in previous years. The summer has therefore been devoted to dredging operations, and valuable results may be expected. The zoological results of the Dutch Arctic Expeditions of 1878 and 1879 are being published as supplemental volumes of the *Niederländische Archiv für Zoologie*; and in the second of these, which is now in course of publication, will be found an elaborate memoir by Dr. Hubrecht entitled "*Proneomenia sluiteri*, gen. et sp.n., with Remarks upon the Anatomy and Histology of the Amphineura."

Eton College, September 24 P. HERBERT CARPENTER

Polydonia frondosa

THE Medusa mentioned by Mr. Archer in NATURE, vol. xxiv. p. 307, is undoubtedly *Polydonia frondosa*, Ag., figured in the Contributions to the Natural History of the United States. This Medusa was already known to Pallas, who described alcoholic specimens sent him from the West Indies by Drury. It is stated by Agassiz to be quite common along the Florida Keys. I have myself observed it in great abundance at the Tortugas, in the moat of Fort Jefferson, and in the mud flats to the north of Key West. They occur there in from three to six feet of water, the disk resting upon the bottom, the tentacles turned upwards; the disk pulsates slowly while they are at rest. Their habits when disturbed are well described by Mr. Archer. The young sometimes swim near the surface, and are far more active than larger specimens. When kept in confinement they also creep slowly over the ground by means of their tentacles, or, raising themselves sometimes edgeways against the sides of the dishes, remain stationary for a considerable time. The resemblance of Polydonia when at rest upon the bottom to large Actiniæ with fringed tentacular lobes, such as Phythactis, is very striking. The peculiar habits of Polydonia were noticed by Mertens in a species named by Brandt *P. Mertensii* in 1838; and found at the Carolines. The genus Polydonia was established by Brandt, and not by Agassiz, as is stated by Haeckel in his "System der Medusen." ALEXANDER AGASSIZ

Cambridge, Mass., August 27

Constancy of Insects in Visiting Flowers

MR. A. W. BENNETT'S paper (NATURE, vol. xxiv. p. 501) on the "Constancy of Insects in Visiting Flowers" recalls a note I made at Cromer during the hot weather of last July. On the cliffs west of that town, where flowers were very abundant and of various colours, I carefully watched the movements of a small tortoiseshell butterfly to ascertain what flowers it visited. It was at first busy with bindweed; then it left this for yellow bedstraw (*Galium verum*), returning presently to bindweed. Then it tried a thistle, which detained it some time, after which it shifted to ragwort, and finally revisited bindweed. It seemed equally busy with all these flowers, though so various in form and colour. My tortoiseshell was therefore less constant than Mr. Bennett's, and its visits were successive, there being no interludes on grass, leaf, tree-trunk, or ground.

Homerton College, E. J. T. POWELL

[In Mr. Bennett's paper, p. 501, col. 2, line 31 from bottom, for *from* read *more*.]

Brewing in Japan

WILL you permit me to point out an error which has crept into the report of my paper on "Brewing in Japan" in last week's NATURE, p. 468. After mentioning the points in which *Kōji* differs from malt, the report continues:—"Kōji is prepared as follows: a mixture of steamed rice and water is allowed to remain in shallow tubs at a low temperature (0°–5° C.) until quite liquid; it is then heated," and so on. The following alterations will make the account of the Japanese brewing process correct:—"*Saké* (rice-beer) is prepared as follows: a mixture of steamed rice, *kōji*, and water is allowed to remain in shallow tubs at a low temperature (0° – 5° C.) until quite liquid; it is then heated . . .". Not using malt as we do in our breweries, the Japanese have discovered for themselves a means of rendering the rice-grains diastatic with allowing the embryo to germinate. This is effected by exposing the softened rice-grains to the action of dry steam, by which treatment the starch is gelatinised; when cold the spores of a mould are caused to grow over the surface of the rice, the mycelium being formed at the expense of the starch, and heat being liberated together with the usual products of combustion. The albuminoid matter of the rice, which previously was for the most part insoluble in water, is, after the growth of the mycelium, found to be almost completely soluble, and the solution possesses diastatic properties resembling those of malt extract. The main point in which it differs from the latter is in its superior hydrating power, for, unlike malt-extract, the solution of *kōji* very quickly converts maltose into dextrose. This material (kōji) is then used instead of malt in the mashing process, the sugar formed from the rice-starch under the influence of the dissolved kōji being dextrose, which is further fermented by the accidental introduction from the atmosphere of the germs of a species of yeast. The change induced in the character of the albuminoid matter under the influence of the growing mould is remarkable, and, I think, novel, and the interest of the observations I have made lies in

the support they give to the opinion that the diastatic property is connected with the degree of solubility of the albuminoid matter, and in the fact that this may result as well from the growth of an organism foreign to the grain as from the germination of the embryo itself. R. W. ATKINSON

College of Science, Newcastle-on-Tyne, September 19

Integrating Anemometer

PERMIT me to observe that the integrating anemometer devised by Mr. Shaw and Dr. Wilson, an abstract of whose paper, read before the British Association (Section A), appeared in your issue of September 15 (p. 467), is in principle and in several of its details identical with a machine intended for the mechanical reduction of anemograms of the Kew pattern adopted by the Meteorological Office, a description of which, with drawings, was placed by me in the hands of Mr. R. H. Scott, and by him transmitted to Prof. Stokes in February last. It is however to be noted that there is a fundamental objection to the mode in which such machines deal with the data submitted to them, namely this, that the air does not, in fact, move parallel to itself, as *these* integrators and Lambert's well-known expression assume that it does. In other words, the integrator should concern itself only with those particles of air which *are passing* the anemometer at each instant, *i.e.* with the directions and velocities of successive elements of the wind at a fixed point. Dr. von Oetlingen (Wild's "Repertorium für Meteorologie," Band v.) has shown this. CHARLES E. BURTON

38, Barclay Road, Walham Green, S.W., September 22

Red Rainbows

THE accounts in NATURE, vol. xxiv. pp. 431, 459, of pink and red rainbows induce me to mention one of a rose colour which was seen in this neighbourhood at sunset yesterday afternoon. Just before setting, the sun shone out with a pale golden glow, but about the north and east there was a general cloudiness, dark inky purple with light masses of cloud floating from north to south, and as the sunset glow lost its golden and assumed a ruddy appearance, these floating clouds took the same colour, the general cloudiness beyond retaining its purple character, and on looking north-east there was the rainbow, or rather the lowest part of the left hand of the bow, almost perpendicular, but inclining, of course, to the east; the general colour was rose, but along the inner side the prismatic colours were plainly seen. It lasted for about five minutes, and was seen by others who were just giving up shooting, about a mile from the house. The clouds in the west soon put on a stormy appearance, and rain began to fall. A. TREVOR CRISPIN

Hyde End, Brimpton, Reading, September 23

Hay Fever

IN Mr. Hannay's letter on Hay Fever (p. 485) two facts are mentioned, viz., that "those who are afflicted with hay fever are so owing to the tenderness of the internal lining of the nose," and that "in Scotland hay fever is practically unknown." By connecting these facts a probable remedy is suggested, viz., the use of snuff. That this habit destroys the natural tenderness of the internal lining of the nose is evident from the insensibility of the snuff-taker to doses that furiously irritate the nostrils that have been differently educated. As Scotchmen generally are either snuff-takers themselves or descended from snuff-takers, a direct or hereditary insensibility may explain their immunity from this affliction. Not being one of its victims, I am unable to try the experiment, which should be started a few weeks before the season commences, in order to gradually develop the acquired insensibility. W. MATTIEU WILLIAMS

Stonebridge Park, Willesden

IN NATURE (vol. xxiv. p. 485) Mr. Hannay remarks that "no remedy yet published will cure hay-fever." Has Mr. Hannay read Dr. Blackley's "Hay Fever" (Baillière, Tindall, and Cox, second edition, 1880)? It will be found that Dr. Blackley has used the treatment mentioned in NATURE, viz. the protection of the mucous membrane of the nose from pollen, with success both on himself and other persons subject to the fever, and Mr. Hannay's experiments offer another proof of the efficiency of this treatment. There is a short article on the subject in the *Lancet* of July 16, p. 82, by Dr. Thorowgood, and another by Dr. Blackley in the *Lancet* of August 27, p. 371. Mr. Hannay's treatment is essentially the same as that published by Dr. Blackley, though in the latter the inconvenience of plugging the entrances to the nasal ducts, and of the stoppage of the proper air-passages, is avoided, whilst the mucous membrane of the eyes is also protected. M. C.

September 24

Electric Light in Collieries

THE writer of the article in NATURE, vol. xxiv. p. 383, has overlooked the long account given in the *Times* of June 14, 1881, of the visit paid by the Accidents in Mines Commissioners to the Pleasley pit, near Chesterfield, where the first important application of the light was made nearly three months ago. Credit should be given to Mr. Swan and to Messrs. Crompton and Co., who for more than a year have been experimenting with, and perfecting, the lamps, &c., rather than to those who may have the good fortune to adopt that which the Pleasley trials proved to be so perfect; and, as one who was present with the Royal Commissioners, I think it only fair to call your attention to what is probably a slip in your report. SESAMY

London

THE ORIGIN AND FUNCTIONS OF THE BRITISH ASSOCIATION

MY attention has been called to a pamphlet published by Mr. W. H. Harrison, purporting to contain a correct account of the first founding of the British Association for the Advancement of Science. I am sure that Mr. Harrison, in common with such other readers of NATURE as take an interest in the affair, will be glad to hear my father speak for himself upon a matter which Mr. Harrison, with the amount of information at his disposal, could only treat of as a subject of speculation. The paper which I inclose was addressed to Sir Edward (then Colonel) Sabine; and I think I may claim for it that it is written with much clearness and impartiality. You may perhaps also consider the letter of importance at this moment, as pointing out what was the view taken in those early days of the proper functions of the Association. The wisdom of this view is abundantly evident now that science has been so widely popularised, and that little more of real work remains for the Association beyond the just apportionment of its funds for scientific purposes. In respect to the numerous scientific letters addressed to my father by Buckland, Murchison, Smith, Sedgwick, Scoresby, Humboldt, Wollaston, Davy, Sabine, Faraday, Brewster, Babbage, Prout, Herschel, Whewell, Forbes, Liebig, De la Bêche, Lyell, and others, I hope some day to cause a selection of them to be produced, in a form which may be of interest, and perhaps of use to the public. E. W. HARCOURT

Nuneham Park, Abingdon, September 23

Account of the Formation of the British Association by the Rev. W. V. Harcourt

"TO COLONEL (AFTERWARDS SIR EDWARD) SABINE

"I HAVE received from the President of the Philosophical Society of Hull (1853), where you know the British Association is about to meet, a memoir which he has put into public circulation descriptive of the nature of that body, its early history, and the specific services rendered to it by individuals.

"The task which Mr. Frost has undertaken is one of a difficult and delicate kind; and I was not surprised to find his description of circumstances with which he had no means of being intimately acquainted somewhat inaccurate and defective.

"Mr. Frost informed the public that when in 1831 Sir David, then Dr., Brewster, made proposals that meetings for promoting science by *réunions* of scientific men similar to those which prevailed abroad should be held in England and commenced at York, the country had been duly prepared and predisposed for such co-operation by the severe strictures which he had then recently passed on the actual state of science in this country, and on the conduct and character of its scientific institutions, and in

particular its universities. It would have been better if these strictures, now forgotten, had not been adverted to, especially with reference to the Association. The truth is, they formed the chief difficulty in carrying such a proposal as had been made into effect. It was clear that any attempt at scientific association not headed or joined by many persons who could not but feel aggrieved by the strictures referred to, and who have been since among the chief lights of the institution, would probably have led to results more mischievous than beneficial to science.

"As soon as Dr. Brewster's proposal was made, and before it could be acceded to, I thought it needful to enter into correspondence with numerous individuals thus situated, and finding that, agreeing for the most part in the opinion that such *réunions* would operate for the benefit of science, they lost sight of all personal feelings, and consented to co-operate on certain conditions, I proceeded to draw up the scheme which was ultimately followed.

"It is a mistake to consider this Association as having been formed on any foreign model. My conception of the manner in which a great scientific combination might be effectually worked in England was founded on different principles. No one could be insensible of the advantage to be derived from bringing men of science together to confer and discuss; but even this point I considered it impossible to gain without extending our views considerably further. I did not believe that the great labourers in science would undergo the inconvenience and interruption of travelling to various places to meet one another, as a continuous system, on mere invitation, and for the sole purpose of discussion, and I knew that if such men should absent themselves from the meetings, those meetings would become no better than *foci* of *sciolism* and vanity.

"I therefore proposed to found the Association on the principle of *acquiring funds* to be devoted to the expenses of unremunerative objects of science, of levying such funds from the multitudes of persons who might be expected to feel interested in scientific discussions at populous places, and giving the appropriation of them first to the selection of committee-men attached to the various sections of science, and secondly to the final determination of the whole body of actual scientific labourers at the meeting assembled in general committee.

"To this principle in the constitution of the British Association its success has been mainly due. To this principle we owed, for instance, the unintermitting attendance, to the time of his lamented death, of one of its ablest members, Mr. Baily, under whose direction one of the largest applications of its funds was made.

"These grants of assistance, conjoined with requests to individuals to execute particular tasks for the interests of science, have given the exertions of the Association as a body a direct utility peculiarly its own, tending far beyond the promiscuous discussions of the sections both to advance material objects and to maintain the attendance at its meetings of persons pursuing such objects.

"The wealth, the public spirit, the intelligence, the curiosity, of the great cities of the United Kingdom, offered great encouragement to the financial part of this plan, which by its adoption has enabled the Association to carry out its entire objects not only in regard to liberal grants for scientific objects and in defraying all expenses incidental to its operations and essential to its permanence, but even in maintaining an establishment of its own for experimental research.

"This plan, proposed by me at York, was adopted in all its detail, and my acceptance of the office of general secretary enabled me, with able and zealous co-operation, to work a machine of great magnitude and complexity with a success surpassing my expectations from 1831 to 1837, during which years I was charged with its chief management, and revised all that was printed in its name.

"The cordial reception of the first meeting of the British Association by the city of York, the hospitality of Bishopthorpe, the countenance of the Royal President of the Royal Society, the presence of Lord Fitzwilliam, the aid of Prof. Phillips, the attendance of the distinguished philosopher Brewster, with Brisbane, Robison, Forbes, and Johnston, the attendance from London of Murchison, from Dublin of Provost Lloyd, from Oxford of Daubeny, from Manchester of Dalton, the concurrence of Buckland and Whewell and Conybeare, and many others of known repute, these incidents helped to launch the vessel; of the early history of which, if any one would write accurately of that part of its history, he may record that Brewster first proposed that a craft should be built wherein the united crew of British science might sail, and manfully embarked in it all his high scientific reputation; but for myself I must be allowed to claim that I manned the ship, that I constructed her charts, and piloted the vessel for six years. The labour which I bestowed on this service has since been divided among more capable hands; but none of us could have worked the vessel at all without the constant and invaluable helping hand of the assistant-secretary, Prof. Phillips.

"I am induced to put down on paper and transmit to you, as actual President of the Association, a statement of the real facts, without the least intention, however, of involving either you or any one else in controversy on the subject."

THE INTERNATIONAL EXHIBITION AND CONGRESS OF ELECTRICITY AT PARIS

THE Exhibition must be pronounced a great success. Even those who are well read in electricity are taken by surprise at the display of power presented; and the first favourable impression is strengthened as further examination discloses the immense variety of applications exhibited and the beauty of much of the machinery.

The first thing seen on approaching the Exhibition from the city is the Siemens electrical railway. It is about a quarter of a mile long, with a sharp turn at one place. The carriage is a good-sized tramcar, and presents no special feature to a casual observer, except two wires which travel with it, and connect it by running contacts with two aërial guides suspended on posts like telegraph posts. The prime mover is a steam-engine near the centre of the Exhibition, which drives a dynamo-electric machine. The continuous current which the latter furnishes is led to the aërial guides, and is conducted by the two travelling wires to an electro-magnetic engine beneath the floor of the carriage which drives the wheels. Passengers are conveyed by this tramcar at a small charge between an outdoor station and a station just within the Exhibition.

On entering the building by this tramway one of the most prominent features is the collection of powerful engines which occupies the whole of the space under one of the side galleries. They are for the most part dynamo-machines driven by steam-engines. The dynamos are close to us as we walk down the main passage on this side; the steam-engines, which drive them by belts, are a little further back; the furnaces and boilers are close to the outer wall. Wires are led from the dynamos to electric lamps, some of them close at hand, and others on the opposite side of the building, or overhead.

Every variety of electric lamp is of course to be seen, and their regulators furnish a very interesting study. To illustrate their diversity we may mention that in the Brush system the regulation depends on the variation of resistance in a series of carbon plates as they are more or less strongly pressed together; in the Crompton it depends on the frictional support of a vertical metallic rod by two pieces which pinch it between them, and pinch it more or less strongly according to the strength of the current; while in the Pilsen lamp a spindle-shaped piece of iron is the common core of two electromagnets one above the other, and is drawn up or down as the contact in one or the other prevails. Then again there are the Serrin and other well-known forms of lamp, in which the carbons are caused to approach by means of clockwork, which is regulated by the strength of the current. There is the Jablochkoff candle, in which the two carbons are parallel and separated by plaster of Paris; the Jamin, which is something like the Jablochkoff, with the plaster of Paris removed, and only air between the carbon pencils; the Werdermann, in which a carbon point below bears against a flat block of carbon above (the point being the positive, and the block the negative terminal); the Joel, in which a carbon point below bears against a disk of copper

above; and the Soleil, in which the point of contact between the carbon point and the copper is surrounded by chalk or lime, which is rendered incandescent.

Then there are the "incandescent lamps," specially so called, in which a thread of carbon a few inches long is inclosed in a vacuous space where, as there is no oxygen, there will be no combustion, and the carbon does not waste. Swan's light, which is of this class, occupies a very conspicuous place in the Exhibition, and is used for the illumination of the Salle des Séances, in which the meetings of the Congress are held. Edison's two rooms are nightly thronged by visitors, who come to see not only his lights, but his numerous other inventions, which are here exhibited. Lane-Fox's light and Maxim's (which has been stopped by some accident) belong to the same class. No opal or ground glass is necessary with incandescent lights, as they are less dazzling than arc lights. They certainly give very beautiful illumination to a room, and their convenience for lecture-room purposes was well seen on the occasion of an illustrated lecture given by M. Mercadier in the Salle des Séances at the meeting of the Society of Telegraph Engineers on Thursday last. They can be extinguished in a moment and re-lighted in a moment.

The Exhibition is open in the daytime from 10 till 6, and in the evening from 8 till 11. The largest attendance is in the evening, when the lights are in full action. Besides those inside, which make the interior almost like daylight, there are two very powerful lights above the roof, which are furnished with reflectors, and throw beams of light like comets' tails in various directions.

The Congress commenced its sittings on the 15th inst., when an opening address was delivered by M. Cochéry, the official president, and the hours of meeting and other details of organisation were arranged. The foreign members were called upon to elect three vice-presidents to join the three French vice-presidents (all official) who had already been named. After a brief conference Sir William Thomson, Prof. Helmholtz, and Prof. Govi of Naples were proposed and unanimously elected. It was agreed to divide the Congress into three sections, devoted respectively to theoretical electricity, telegraphy with telephony, and miscellaneous applications of electricity, including the electric light; the first section meeting at 9.30 a.m., the second at 2, and the third at 4 p.m. Each section has sat for about two hours daily, an interval of two hours between the first and second being allowed for *déjeuner*.

M. Dumas was elected president of the first section, with Prof. Kirchhoff and Dr. De La Rue as vice-presidents, Prof. Mascart and M. Gérard being secretaries. The discussion of the subject of international electrical units, the choice of which is regarded as the most important work of the Congress, was then begun, and occupied the rest of the sitting. Sir William Thomson introduced the question in a very lucid speech, in which he described the course which had been taken by the British Association, and recommended a substantial adoption of the British Association system. He was followed by Professors Wiedemann and Helmholtz, who favoured the adoption of a mercurial unit of resistance; and a large committee, containing men of both views, was appointed to draw up a Report. This Report was anxiously awaited, and was presented on the 19th inst. It consisted of the following seven recommendations, which had received the unanimous consent of the Committee, and have now been formally adopted by the Congress.

1. The fundamental units for electrical measurements to be the centimetre gramme and second (C.G.S.).

2. The practical units ohm and volt to retain their present definitions, 10^9 for the ohm and 10^8 for the volt.

3. The unit of resistance (ohm) to be represented by a column of mercury of a square millimetre section, at the temperature zero Centigrade.

4. An international commission, to be charged with the duty of determining by new experiments, for practical purposes, the length of the column of mercury, of a square millimetre section, at zero Centigrade, which represents the value of the ohm.

5. The name Ampère to be given to the current produced by a volt in an ohm.

6. The name Coulomb to be given to the quantity of electricity defined by the condition that an Ampère gives one Coulomb per second.

7. The name Farad to be given to the capacity defined by the condition that a coulomb in a farad gives a volt.

It will be observed that the "weber," a unit familiar to British electricians, is not mentioned in these resolutions. The reason, as stated by Prof. Helmholtz to the Congress, is that Weber himself employs a unit of current derived from the millimetre, milligramme, and second, and this unit, which is one-hundredth of the C.G.S. unit, or one-tenth of the weber, as commonly understood by British electricians, is known as "the weber" in Germany.

The reason for adopting a mercurial standard defined by size was explained by Sir William Thomson to be the desire to guard as much as possible against secular change.

It transpired in the discussions which took place in committee that mercurial standards, as actually constructed, are glass tubes which must be refilled with mercury every time they are to be used. The external communications are made by means of platinum wires attached to plates of the same metal, the latter being well amalgamated before use. It is obvious that these operations involve much more labour and risk of error than comparison with a standard coil; and we therefore do not anticipate that recourse will be had to the mercurial standard except on rare occasions. Coils will as heretofore continue to be used for all ordinary measurements of resistance. The international committee which is to make the new determination will be nominated by the governments of the various countries concerned, and independent determinations will doubtless be made by different members of the committee in different laboratories. It will thus be seen what amount of consistency is attainable in such measurements, and whether it is sufficient to render the standard practically accurate. The German authorities assert that accuracy to one part in two thousand can thus be ensured.

THE CAUSE OF COLLIERY EXPLOSIONS

ONE of the most instructive documents ever penned on the subject of the cause of explosions in collieries has recently appeared, in a lately-issued Blue-book, in the form of a Report to the Home Secretary by Prof. Abel, C.B., F.R.S., of Woolwich, who, at the request of the Home Department, conducted a series of experimental researches upon the cause of the terrible disaster at the Seaham Colliery on September 8, 1880. In 1845 Faraday and Lyell first directed attention to the influence exerted by the presence of *coal-dust* in mines upon the magnitude of an explosion of fire-damp. In 1867 and 1875, the subject was further advanced in France by Messieurs Verpilleux and Vital, the latter of whom showed that air charged with fine coal-dust, rich in inflammable material, may explode when there is present a much smaller proportion of true fire-damp than is of itself sufficient to constitute the atmosphere an explosive one. Still more recently Mr. W. Galloway has conducted a valuable series of investigations and experiments, the results of which have been communicated to the Royal Society in three very important memoirs. In the first of these he showed that a certain mixture of air and coal-dust, not itself inflammable, became so when there was also present a much smaller proportion of fire-damp than any Davy lamp could detect. In the second he showed

that the return-air from the ventilating shaft of a mine may actually contain enough fire-damp to become inflammable when coal-dust is diffused into it. In the third he concludes that the influence of the coal-dust must not be considered as merely aggravating and increasing the explosion originating with the presence of fire-damp, but that the presence of the dust must be regarded as the one thing which, if a small explosion takes place anywhere, will accumulate and carry forward the force of the explosion with ever-increasing energy into every empty space in the workings, however ramified.

During the current year, experiments have also been made on the subject; at Harton Colliery (Durham) by Mr. Wood and Prof. Marreco, at Broad Oaks Ironworks by the Chesterfield Committee of Engineers, at Garswood Hall Colliery (Wigan), by Mr. Smethurst and the Royal Commission on Accidents in Mines, and lastly at Woolwich by Prof. Abel. The general character of the experiments has been on a plan originally devised by Mr. Galloway: viz. to expose to a flame, or to the flash of a small cannon, a stream of air in a miniature gallery into which any desired percentage of coal-gas or fire-damp was introduced, and into which coal-dust could be diffused by a hopper; arrangements also being made to raise the temperature of the gases, and to increase their velocity at will. The majority of the experimenters believe that in no case does a mixture of air and coal-dust *without fire-damp* explode, although the Chesterfield Committee think they have evidence that flame will travel in dust-laden air without a trace of fire-damp being present. This matter is of great importance, for it has been shown that in flour-mills explosions which have occurred may be traced to the presence of combustible dust in the air.

Prof. Abel had placed in his care thirteen samples of dust, some burnt, others unburnt—collected from different parts of the Seaham mine; which samples were subjected to careful examination in the microscope, and to chemical analysis. They were found to contain from 64·83 to 99·75 per cent. of pure coal-dust, some of them containing ash, grit, and fine sand in various proportions. They were then tested as to their power to aid in producing explosions in an experimental gallery. The gas employed was an explosive pit-gas, of such a quality that a mixture containing only 3·5 per cent. of the gas with air when travelling with a moderate velocity (from 200 to 1000 feet per minute) was ignited by the flame of a naked Davy lamp. In perfectly still air from 4 to 4·5 per cent. of the same gas was necessary to produce the same result. Currents of mixtures of this gas were conveyed into the experimental gallery at a velocity of 600 feet per minute, and at a temperature of 80° F.; a naked Davy lamp, its flame protected from the draught by a small screen, being placed in the gallery at about 12 feet from the place where the dust was supplied to the current. More and more fire-damp was gradually added until explosion took place; that dust being regarded as *most sensitive* which produced explosion with the least percentage of fire-damp. When the relative sensitiveness of the various samples of dust had thus been ascertained, it was found that, of the four which stood head of the list in point of sensitiveness, three headed the list also in point of richness in combustible matter and in point of fineness of texture. But the sample which stood third in point of sensitiveness was not only not the finest, but stood absolutely bottom of the list, in point of richness. It therefore appeared that porosity and mechanical condition are more important than combustibility of the dust in bringing about the ignition of a fully explosive gas. Prof. Abel was led, in consequence, to try whether the ignition of a mixture of air and fire-damp in a low percentage not inflammable of itself by contact with a lamp-flame could be brought about by the agency of a wholly incombustible dust. Accordingly dust such as calcined magnesia, powdered chalk, and slate-dust was tried; and it was found that instantaneous explosion was thereby produced in currents of air containing only 3 to 3·5 per cent. of fire-damp. It appears then that *dust of any kind*, as a finely-divided solid, can operate in determining the explosion of an otherwise harmless mixture of gas and air; probably by furnishing, as the particles pass through the flame, successive red-hot nuclei, by which the heat is localised and rendered more intense.

In the special case of dust that is both fine and combustible, as coal-dust may be, it was proved that so small a proportion of fire-damp as 2 per cent. in moderate currents may determine the propagation of a flame by coal-dust. Now, as it is stated on the best authority that the most experienced eye cannot detect the presence of 2 per cent. of fire-damp by its effect on the flame of the ordinary Davy lamp; and as (in spite of all the host of little inventions to detect smaller percentages) the Davy lamp remains the only practical test of the presence or absence of fire-damp in fiery mines, it follows that, in every mine where there is any fire-damp *at all*, the mere dust of the mine constitutes an element of danger of which the risk is simply incalculable. When we add to this that experiments, made by firing such small blasts as eighty *grains* of gunpowder may represent, show that dust may cause the propagation of flame in air-currents containing percentages of fire-damp *far smaller than any* of those mentioned above, it is clear that whatever the risks with Davy lamps may be, they sink into insignificance beside the frightful dangers attending the firing of a shot for purposes of blasting. The practice of blasting the coal cannot be too emphatically condemned. It is at best a lazy and slovenly process of getting the coal, and considering the risks it entails, ought to be stringently and at once put down by legislation.

The practical moral is that, while the Davy lamp is to be regarded more than ever as a necessary of work in the pit, it cannot be regarded in any way as a safeguard of absolute kind against explosion; still less can it be regarded as an indicator of the presence or absence of impending danger, inasmuch as it is absolutely incompetent to detect such feeble percentages of gas as Prof. Abel has shown to be dangerous in the presence of the inevitable dust of the mine.

Science, which gave us the safety-lamp, must therefore be called upon once more to provide efficient substitutes. (1) A new lamp, electric or otherwise, must be devised, which shall be wholly independent of a supply of air from the galleries in which it is used; (2) an indicator must be invented to do what the Davy lamp fails to do, viz. to detect in the workings of the mine the presence of a proportion of fire-damp less than 2 per cent., and to indicate rapidly and accurately its amount. Let us hope that Prof. Abel will crown his labours by giving us such new instruments.

THE LANDSLIP AT ELM

THE Swiss papers contain valuable information as to the landslip which occurred on September 11 in the valley of the Sernft River, in the canton of Glarus. The month of September is notable in Switzerland for landslips. Thus the great landslip of the year 1618, which buried the whole of the town of Plurs in Graubünden, with its 2340 inhabitants, occurred on September 4; and the great downfall of the Rossberg Mountain, which destroyed the village of Goldau, with three other small villages, burying 111 houses and 457 persons, and filled up the Lake of Lowerz, occurred on September 2, 1807. The very heavy rains of the last few weeks have softened the rocks on the slopes of the Plattenberg Mountain, at the foot of which, at a height of 3330 feet, was situated the village of Elm, now almost completely destroyed by the landslip. The clay-slate quarries which were worked

upon the same slope have divided the masses of the rocks into large pieces, whilst the frequent earthquakes of the last months have given rise to large crevices in the slates and limestones. Already on September 9 it was perceived that the soil at the quarry was in slow motion, and a house situated immediately below was evacuated. Two days later, between five and six o'clock in the afternoon, it was seen that the forest on the slope of the mountain began to move, the trees being bent like a field of corn during a strong wind; they then rushed down, together with the rocks situated above the quarry, breaking up into thousands of pieces. This formidable stone avalanche reached the village, the trees were bent like straw, and the houses moved by the pressure of air pushed by the landslip. Men and houses were thrown on the opposite side of the valley, smashed against rocks, and buried by the landslip, which, as in the catastrophe of the Rossberg, crossed the valley and rose up-hill on its opposite side. The first landslip destroyed that part of the Elm Commune which is named Unterthal; but a second one followed immediately, destroying the village, and throwing the houses on the opposite side of the valley, one kilometre wide. The picturesque valley of Unterthal is now covered with a mass of mud, earth, and stones, thirty to forty metres thick, on the surface of which are seen blocks of the size of a house. The length of the landslip is about two kilometres, and the opposite side of the valley is covered with stones and blocks on a space of about 100 metres. The Sernft River, which flows in the valley, is barred by the *débris*, and has formed a small lake. The number of persons killed is about 160. Another small landslip occurred on the following day, and the slope of the mountain continues to be in motion. According to a report of Prof. Heim the remnant of the village is also threatened by a landslip, the Risikopf, or Grosskopf, being creviced and undergoing subsidences which render a landslip most probable, not so large, however, as the preceding one.

The *Times* Geneva correspondent writes under date September 19:—"According to the measurements and estimates of Prof. Heim, of Zurich University, who has just visited Elm, the earthslip of yesterday week, though less destructive of human life than the earthslip of Plurs and Goldau, probably exceeds in extent either of those catastrophes, great as they were. The portion of the Tschingel Alp which broke away from the parent mountain measured at its base 400 metres by 350 metres. The length of its projection outwards cannot, of course, now be ascertained. The length of what Prof. Heim calls the *débris* stream is 1500 metres, and varies in breadth from 300 to 400 metres. The distance of the extreme end of the stream from the place whence it broke away is 2000 metres. The extent of the valley bottom, which is tolerably even, covered by *débris* is computed at 570,000 metres, while the entire mass makes a total of 900,000 square metres. From the lower part of the valley to the upper joint of rupture the height is 620 metres. The fall was, therefore, a little over 2000 feet. The lowest estimate of the contents of the slip, according to the admeasurements of the engineers, is 10,000,000 cubic metres. It contains, says the Professor, enough stone to build two cities as large as Zurich, and the population of Zurich is 76,000. Some of the blocks, which are heaped 112 metres higher than the village of Elm, measure 1260 cubic metres, and are estimated to weigh 3300 tons. If the other earthslip, which is regarded as imminent, should take place, all that remains of Elm will be destroyed."

The heavy rains of the last weeks have caused several other landslips in Switzerland and Savoy. In the Upper Singine, in the canton of Freiburg, the soil is in slow motion in the valleys of the Gérine and Singine rivers, and a landslip of some importance has occurred at Planfayon. Another landslip occurred on September 2, close by Bernex village, on the slope of the Dent d'Och, and it is rather remarkable by the circumstance that it occurred in a broad open valley where one never would suppose the possibility of a gliding of rocks.

A further interesting result of the recent heavy rains is that the Lake of Bicune, which is somewhat lower than that of Neuchâtel, is now so full that its water runs into the Lake of Neuchâtel, inundating its shores.

PHENOMENA DEVELOPED BY HELIOSTATIC STAR-DISKS

A HELIOSTAT of the highest class is doubtless beyond the means of ordinary observers, but such an instrument as the one now described is readily obtainable. Three sets of achromatic lenses forming a focal power of forty at ten inches, or a miniaturing power of one-fortieth, are in general sufficient. If formed into a microscopic object-glass, the front is turned towards the sun. The glass then refracts a beautifully small star-disk, which, owing to the large angular aperture of the combination, remains steadily in view for several hours. The optical characters of this disk vary considerably with the quality of the lenses; practically a very fine one-quarter by Powell and Lealand produces disks of remarkable beauty and precision. In some cases a plane mirror is conveniently attached to reflect the oblique solar rays.

The instrument thus provides a stationary solar star-disk for continuous observation. No clockwork or machinery is required. The size of the disk is one-fourth of the sine of the solar diameter, or nearly 45-10,000ths of an inch.

A more brilliant form of surpassing effulgence is occasionally employed by a 3-inch lens placed before a right-angled prism. An aërial image of the sun thus produced outshines the electric light. These disks are viewed at a distance of ten feet.

It is proposed to describe first their use in microscopic research, and secondly for telescopic vision.

I. Microscopic Research

The Miniature Method.—A strong plate fitting the upper stage of the microscope by means of screws is pierced in the centre by an aperture carrying the "societies" standard screw, into which an objective can be firmly screwed. The stage motions then give readily the necessary adjustments for coincidence of optical axes. This is called the *stage-holder*. All previous methods of fixing the objective in the sub-stage have been abandoned; the necessary steadiness being almost unattainable.

Phenomena of Heliostatic Star-Disks produced by the One-quarter.—Stage-holder armed with an inverted 1-32nd water-immersion. The miniature of the star-disk is now viewed microscopically with a 1-16th immersion. When both of these objectives are adjusted for the most brilliant vision, *distant foliage is distinctly visible*. A flag-staff carrying the Union Jack 180 yards away displays its double cross. The fine lightning-rod surmounting it is distinctly visible. Houses on a hill glisten in the sunshine; but conspicuous above all is the minute solar star-disk blazing with all the glory of a midday Sirius at the open window-sill.

Here the favourite tests for telescopic precision come richly into play. A minute brilliant bead surrounded by the most intensely black ring—the more wonderful as the brilliance seems to heighten its rare and beautiful delicacy and blackness—comes up and plays into expanding coloured rings on each side of the principal focal point. (The delicate beauties of this exquisite phenomenon cannot well be seen without an exceedingly delicate fine focal adjustment.) The focussing wheel (constructed for the lightest contact) is divided into 132 parts; twenty-six give a focal plane the 1000th of an inch deeper or higher,

but a tenth part of this, or a change of focus of the 10,000th of an inch, changes the appearance of the magnified star-disk. These changes, so vivid and sudden, produce a lively impression of the minuteness of the wavelets of light which generate these diffractive phenomena.

The diameter of the brilliant disk, as miniatured, is about the 1-20,000th of an inch; the jet black ring in which it appears set, and indeed well set-off, is about 1-100,000th thick. Slight changes in the focus, but especially slight changes in the corrections of the observing and miniaturing glasses, produce a new order of phenomena, full of a significant meaning and practical import. The minimum visible is perpetually forcing itself upon the observer's attention. The lightning-rod (here visible) 6000 inches away, is miniatured 600 times smaller than at 10 inches by the 32nd objective, which then would diminish an object only 320 times. The rod is therefore depicted nearly 200,000 times smaller. It is exactly half an inch in thickness; its size therefore in the miniature is 1-400,000th.

As the evening light faded away a long row of gas-lights reaching half a mile came into view in pretty perspective, the more distant being very slightly out of focus (six divisions). The 32nd objective required to be advanced the 4000th part of an inch for the distant light. In this case the miniature was produced by a Zeiss 1-32nd, and viewed by another 32nd by the same maker. The lowest eye-piece is employed and a shortened eye-tube. A single glance at these microscopic landscapes satisfies the observer at once as to the quality of the instruments of observation. Achromatism is seldom attained without generating a whitish haze, the inevitable accompaniment of residuary spherical aberration. This haze is an invaluable indication.

The haze observed in miniatures examined by high magnifying power is an invaluable indication of spherical residuary aberration. The method gives a cruel test of the optician's art. Its discovery led to the subject coming before the Royal Society and its being embodied in their *Transactions*. When first seen it was exhibited as a strong yellow fog. The announcement of it occasioned the greatest surprise to the distinguished makers of a "very fine" set for the writer. In most cases the higher the angular aperture the denser was seen the fog. The following is quoted: "Mechanical arrangements are shown by diagrams, Figs. 1, 1*a*, plate LII." (*Phil. Tr.*, vol. ii. 1870, p. 592).

"*Experiment I.*—Miniature of a small thermometer, the ivory scale being graduated 24° to the inch. A power of 300 diameters: low eyepiece 'A' and objective of one-eighth focal length (made expressly for Podura testing) was applied to view the miniature formed by a one-sixteenth objective. The following appearances were carefully noted at the time of observation:—

"*Result.*—The sparkle of light on the bulb of the instrument, the graduation, and the mercurial thread within the glass are invisible, obscured by a nebulous yellow fog which no objective adjustments are able to dissipate."

In consequence of this unexpected discovery regarding the quality of a "very fine" one-eighth, it was returned to the opticians, to their surprise, for better compensation. After improvements a very slight nebulous yellow cloud now only remained.

A new fact now came up. A *miniature* formed by an imperfectly corrected glass is comparatively free from the aberration shown by the same glass used as a microscope. Thus, viewed by a good glass, the miniature of an inferior one bore wonderful magnification by an excellent objective.

In innumerable objects surface markings are shown only: with no perspective and with no foreshadow of deeper structures such objects are opaque. But if transparent, the foreshadow of deeper structures confuses the appearance of surface; strange eidola are generated difficult of interpretation and dispersion. A series of star-disks in deeper foci intermingle their diffractions into beautiful forms.

The strong fact that these diffractions of a given disk are wholly developed towards the eye of the observer, or wholly developed beyond the true focal plane, according as the correction of the glasses is over-wrought or under-wrought, reveals an infallible clue to many spurious effects. This method therefore more severely tests the observing instrumentation than the miniature.

The following experiment, arising out of the phenomena in course of observation, is quite a microscopic study in itself:—

Experiment.—Miniature of garden view formed by a 1-30th plano-convex lens and examined by a microscope armed with 1-8th giving 400 diameters.

Result.—Landscape dark and hazy. But upon using the same power (400) with a deep eyepiece and a half-inch objective, there started forth an exquisite picture brilliantly lit up. Even the foliage glittering in the sunlight was sharp, clear, and decisive, the details being marvellously displayed. This large increase of light with diminished observing angular aperture is at first sight astonishing.

It is to such causes doubtless that the microscopic world so long disputed whether the markings on diatoms were depressions or elevations. The earlier plates of such objects, as given by Quekett, teem with eidolic varieties of form. It was thought impossible to resolve them, as it was called, without complicated stops, which in fact shut off the unsuspected residuary aberration.

But it is necessary to pass on to the *fundamental circular spectrum* of a minute solar disk. A simple plano-convex lens of half an inch focus is placed on the microscopic stage and made to form a miniature of the prism star in the field of the microscope. If the experiment be properly conducted, forty gorgeously coloured rings may be counted. I have frequently examined these phenomena with a power of 1000 diameters. Above the best focal point is a bright fog; below are seen the glorious diffractions. The sun, as far as it could be made out, was a spurious disk nearly 6-100,000ths of an inch; the first black-ring, the blackest thing I ever beheld, was nearly the 1-50,000th. Each ring beyond appeared exactly of the same breadth—nearly the 1-16,000th.[1]

If now an over-corrected lens were substituted, the diffraction rings ascended and the nebulosity descended: they exactly changed positions as regards focimetry. The conclusion follows that all brilliant objects present diffractions above or below the true focus according as the observing instrument is over- or under-corrected by means of the usual screw collar adjustment.

In this way the same object, especially diatoms, may be made to take several very deceptive forms, because spuriously diffracted. The same is true of all brilliantly illuminated transparent structures.

The intersection of an infinite number of cones of light converging to different points of the axis here produces the well-known interference extinction of undulation evolving precisely-formed rings of darkness. The simple lens, in these observations, develops circular spectra, as being formed by an infinite number of prisms.

An important outcome of this phenomenon is the unerring test (here presented by a simple single convex plane lens) of the highest possible order, as to the *quality*

[1] The contemplation of these phenomena, utterly eclipsing in their brilliant beauty and precision of form the fainter diffraction phenomena described by Sir John Herschel as amongst the most gorgeous in nature, astonishes every beholder. Some little skill is required in gradually toning down the excessive, I might say painful, glories of the appearances—lengthening the eye-tube; glass tinted wedges (a single field-lens of a Hyghenian as eyepiece produced a spectrum apparently twelve inches in diameter, measured with the left eye by rule laid on the stage), or by camera.

or inferiority of the observing microscope. Extreme steadiness and a *particularly* delicate fine focussing adjustment are indispensable for successful observations. It is impossible here to detail them.

A plain silvered mirror of the old style must be discarded as a solar reflector; prismatic internal reflexion or reflexion from a metallic surface is indispensable for producing purity of spectra.[1]

But it is when superb objectives are placed as it were eye to eye, that the finest observations can be made (especially when both are used with their noses inserted in the proper immersion fluid for observing landscapes) on distant objects.

The extreme delicacy of the change in focal planes of vision is charmingly illustrated by observing with a good 1-8th the miniature of two brilliant points, the one 200 inches, the other 201 inches away in the same line. If the miniature is formed by a simple lens, theoretically the focal images of these star-disks would be separated by an interval of 2-10,000,000ths of an inch for a 1-10th lens, *perfectly* aplanatic.[2]

These disks, by their rapid change in appearance, give the most exquisite means of determining focal changes in the microscope. Thus for a focal depression of 7-10,000ths of an inch a change took place from *one* pure jet black diffraction-ring round central disk to eleven rings. The rings changed visibly for a focal depression of 100,000th of an inch.

The greatest confusion has existed regarding the terms penetration, definition, and resolution. The study of star disks miniatured by surpassingly well-corrected glasses furnishes the observer with a new order of facts upon which irrefragable conclusions can be founded.

A telescope of very fine quality should have a focus of extreme delicacy. One whose change of focus by 1-10th of an inch produces little or no effect upon the "definition" is contemptible. In the same manner the quality of microscopes may be estimated by the striking effects of a minute focal change. The planes of focal vision, it will be found, vary extremely, their interval varying according to a function of several complex factors.

The prism-heliostat already described is well represented by an Amici prism. Small bulls-eye lenses, laid with the convex surface upwards in the sunshine, present two brilliant images of the sun at a distance of 200 inches. They are of unequal brilliancy. A row of these placed in a line with the axis of the instrument,[3] and somewhat tilted, so that the star-disks may be all seen at once, will develop a series of fine microscopic effects, dependent on the corrections of the systems in use and the immersion-fluid in which the noses of the glasses are inserted (sometimes a piece of adherent glass cover intervening, as the water tends to run off). If a 1-33rd objective be employed to miniature them, and a 1-16th to observe them, extraordinary fine excellence insures a perspective almost as clear as an opera-glass. The minute double stars—which may be brought as close as we like by change of the angle of position of the instrument with the sun's azimuth—produce a variety of diffraction rings, mingling, crossing, and breaking up each other in a manner that could hardly be suspected during the telescopic observation of real double stars. Seldom can a bright landscape be attained without leaving some little outstanding colour. If that be destroyed by changing the glasses or corrections immediately, *all black objects look grey*, and the grey becomes lighter as the colour nearly vanishes. The rest of the view is charged with a thin greyish-white nebulosity, the sure indication—as already described—of residuary aberration. Just within the best focus an exquisite little dark-grey bead margined with black—much less than the primary brilliant disk (half its size)—may be discovered by close attention and a particularly well-adjusted focussing apparatus.

In observing these interesting phenomena it will be seen that larger[1] and smaller spurious disks are formed according to the curvatures of the bulls-eyes; but there is one minimum size; and these, when contiguous, illustrate diffraction spectra in a brilliantly instructive form.[2]

Upon a proper arrangement, putting the bulls-eye and the instrument nearly in a line with the sun's azimuth, a superb representation of the double star, Castor, is seen, the fainter star being that caused by internal reflection. Intensely black diffraction rings round each, and several fainter ones, fewer as the quality of instrumentation is raised. Perfect roundness can only be attained by exact coincidence of the optical axes of the system. Very slight obliquity (even half a degree) causes the rings to overlap and bulge on one side. Much obliquity gives rise to glorious curves of the three orders of the conic sections, of wondrous beauty and precision in effulgent colours.

Mercurial globules near the microscope exhibit very delicate and complex forms when similarly miniatured, as minute solar disks, in sunlight.

Experiment.—An optician's gauge comprising half a dozen lenses of standard foci 1" to 1·6"th, lying in the sunshine, miniatured star disks by reflection (see (1) in figure. Inferior objective 1½ inch examined with fine power of 1000. Two brilliant crimson disks in contact expanding within focus to an oval ring of deep crimson beads.

Experiment.—If the image of the sun be received on white paper from a small lens placed at various degrees of obliquity peculiarly beautiful forms are seen fringed with colour. When the lens is sufficiently minute these spectra exhibit to the microscope exquisitely-arranged curves in jet-black lines; circular elliptic parabolic and hyperbolic, with inexhaustible variety, according to the focal plane of vision and obliquity. Heliostatic star-disks most successfully exhibit these unique phenomena. The superiority of these phenomena to anything telescopic of the sort is insured by the absence of atmospheric disturbance within so short a distance. They are all under instantaneous control.

The limits of human vision among so many bright points are patent enough. So long as there is bright sunshine every glittering point obscures, I might say utterly effaces, the finer traceries of detail. A passing cloud, however, brings them all out with astonishing fidelity. Brilliant diffraction is thus demonstrated to be incompatible with exact portraiture. The limit is reached in brilliant sunshine by the diffraction disks obliterating the very objects which produce them. This limit is well measured by the diameter of the smaller disks seen in contact, which in white compound light generally appears by micrometric measurement to be between the 1-80,000th and 120,000th of an inch in the microscopic field.

We need not be surprised at this variation: the undulatory theory of light gives *one* size only. Yet, as the spurious disk by theory is shaded off *gradually* into the

[1] Some indications of quality in microscopes:—(1) Confused mass of spurious disks oddly arranged; (2) Beauty of rings utterly marred; (3) Very few rings definable; (4) Spectrum notched, grained, and spotted; (5) Systems of excentric rings dark and coloured, much confused; (6) An "engine-turned pattern" mottled and degenerated; (7) Achromatism and freedom from spherical aberration in all cases found incompatible. The universal presence of some residuary spherical aberration is demonstrated by several irrefragable proofs in all the finest-made modern glasses.

[2]

First conjugate focus distance	0'10005002
Second " "	0'10004977
Interval between foci	0'00000025

[3] The miniature-making objective and observing microscope are both placed horizontally.

[1] Luckily the image of the sun is very nearly the hundredth part of the focal length of the lens employed. If a bulls-eye of 1-inch focal length be employed at 200 inches, and a miniature be produced by a 1-8th, diminishing it 20 × 80, or 1600 times, the observed image of the sun would theoretically be 1·1600 × 100 = 1·1,600,000 less than one millionth of an inch. It should be noted that if the primary axial image of the sun be too large, no diffraction spectra will be developed at 200 inches, unless very deep miniature-objectives be employed.

[2]

The January sun image formed by 1-inch lens is			1·106th inch.
The April	"	"	1·108th inch.
The July	"	"	1·109th inch.

first intensely black first ring, fainter stars telescopically show smaller disks.

But whilst a close row of spurious disks are seen to coalesce and obliterate themselves if too close, and become continuous as a thick luminous line—the necessary effect of bright diffractions—duller objects devoid of brilliance are seen of amazing minuteness of tracery.

Example.—The rungs or rounds of a ladder resting against a house half a mile off were distinctly seen when miniatured down to 1-1,000,000th of their actual size, *i.e.* considerably less than 1-1,000,000th of an inch. This feat was accomplished by an immersion 1-32nd by Seibert, which diminishes an object 30,000 inches away just about 1,000,000 times. The bane of minute microscopic research is thus seen to essentially consist of a combination of diffraction with the haze of aberration.

A blue glass evidently diminishes the diffraction phenomena; so do neutral tints. This exactly tallies with the shrinking of spurious telescopic disks during haze and sky-clouding. These facts forcibly point out the great advantages of observing in mild light. In further support of this the writer has thus effected several very difficult resolutions—in the "Ultima Thule" of microscopic investigation glare is the prolific parent of many fallacious interpretations.

These studies have encouraged the writer to continue a research into the limits of human microscopic vision. In the case of bright illuminations the limit is evidently reached at once. A minute refracting spherule thus forms a bright focal point which itself exceeds by expansion into a spurious disk, the diameter of the spherule producing it. Down to a certain size a focal image is discernible. A very interesting study is given by the solar star-disks presented by receiving the rays from the heliostat after passing through a beetle's eye placed on the field of view on the stage of the microscope.

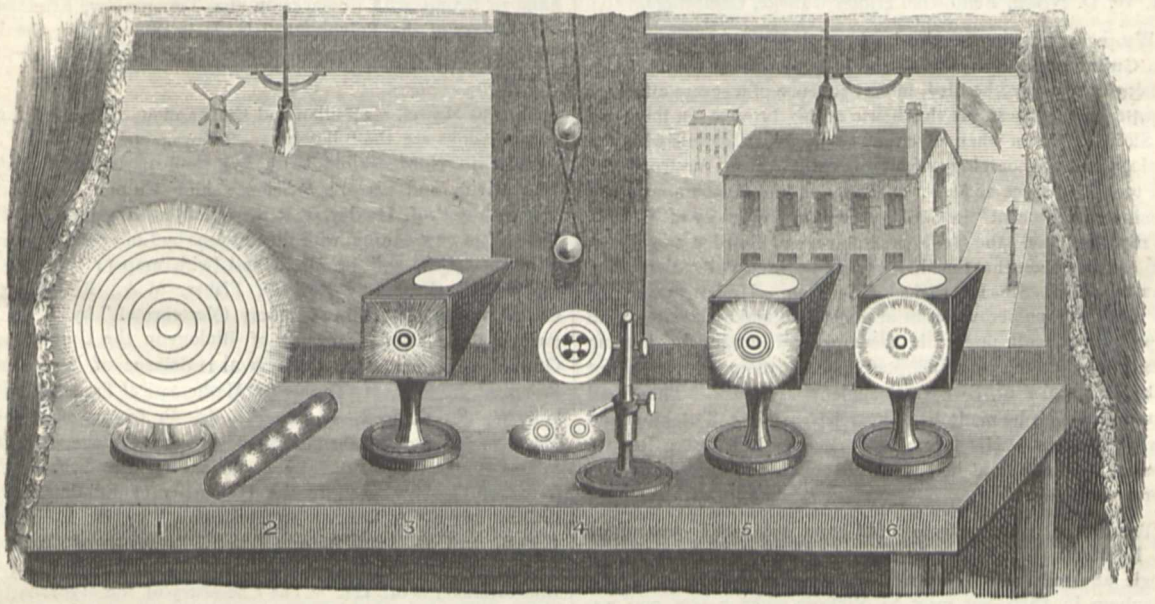


FIG. 1.—Taking the objects fron. left to right, a representation is given of a miniature magnified a thousand times linear and the various appearances of the heliostatic star disks with slight changes of focussing. 1. Large diffraction rings: *fundamental spectrum* given by a plane convex lens ½ inch focal length placed on stage of microscope. Forty rings have been counted. 2. Optical gauge: various lenses showing spurious disks with minute diffraction rings similar to those on the "bulls-eye" in centre of picture. 3. Intensely clear bright star disk produced by very perfect instrumentation. 4. A cross given by imperfect glasses. 5. Larger expanding rings, the miniature or observing glasses being either under or over-corrected. 6. The finest and clearest spurious disk attainable.

NOTE.—The house on the hill distinctly seen in this case of very finely corrected glasses. A miniature formed by a very fine 1-32nd gives the distant house and window nearly in the same focal plane.

Until the sun shone the window appeared miniatured in each eye. It seems curious to measure the focal length. By measuring the images this was found to be 1-1000th of an inch, giving enormous magnification for ordinary vision.[1] The solar disk, however, appeared spuriously enlarged.

More wonderful diffraction-phenomena are developed by different treatment. A half inch condenser-objective was inserted between the coleopterous eyes and the heliostat—behind or beyond the stage. The solar disks developed then appeared severely beautiful. No such wonderfully sharp black rings are even viewed telescopically. These phenomena are in order of focal classes—

1. Intensely black truly formed rings.
2. Hexagonal black patterns on a brilliant ground.
3. Three such hexagonal rings to each eye-facet.
4. Five such finished off with extremely rich Scotch plaid patterns, highly coloured.

G. W. ROYSTON-PIGOTT

[1] Their focal length was measured by selecting a well-defined object, as a red brick house, carefully measuring micrometrically a given part of it, and then measuring an image of the same thing in a known lens.

If d be the distance of the object from its image, m the size of its miniature, M the size of the object,

$$f = d \times m \div M.$$

A convenient formula for estimating the focal length of a small lens was given by me in the *Phil. Trans.* If it is found to magnify m times at a distance *between object and image* d, and if m be considerable,

$$f = \frac{d}{m+2}, \text{ more accurately} = \frac{d}{m + \frac{1}{m} + 2}.$$

NOTES

THE Delegates of the Clarendon Press will shortly publish an "Elementary Treatise on Electricity," by the late Prof. James Clerk Maxwell, edited by Mr. W. Garnett, formerly Fellow of St. John's College, Cambridge. The book was commenced about seven years ago, but its completion was prevented by the author's other engagements; so that during the last three years of his life very little was added to the work. After his death the first portion of the manuscript, on Statical Electricity, was

found in a finished state, as well as some chapters on Current Electricity. The book has been completed so as to cover the subjects included in the first volume of the larger Treatise on Electricity and Magnetism by a selection of some of the simpler articles from the last-mentioned work. As in the larger treatise, the "method of Faraday" has been followed throughout; but no knowledge of the higher mathematics has been assumed, and geometrical methods have been almost everywhere adopted. Very much of the matter contained in the work will, we are informed, be new to readers who had not the advantage of attending Prof. Maxwell's lectures at Cambridge, and the whole book bears indelibly the stamp of Prof. Maxwell's originality. It is as much unlike any other book on electricity as the "Theory of Heat" or "Matter and Motion" is unlike other books on thermodynamics or mechanics. The Clarendon Press likewise have nearly ready for publication a second edition of Prof. Clerk Maxwell's "Treatise on Electricity and Magnetism," edited by Mr. W. D. Niven, Fellow of Trinity College, Cambridge.

WE regret to announce the death, at the age of forty years, of Dr. Gustaf Linnarsson, the able palæontologist to the Swedish Geological Survey; he died, in consequence of a severe attack of disease of the chest, at the house of his brother, in the town of Sköfde. Even when at school he occupied himself with the geology and palæontology of his native province, Westrogothia. He took his degree as M.A. in 1866 with high honours, and was nominated "Docent" in Geology at the University of Upsala. In 1870 he joined the Geological Survey of Sweden as palæontologist, and since that time has worked at the classification of the Cambrian and Silurian rocks of Sweden. He has expounded his views in a numerous series of geological and palæontological papers, which all prove his accuracy and caution in drawing conclusions. The now adopted classification of the oldest Palæozoic rocks of Sweden is chiefly his work. The fossil groups in which he made his researches are the Trilobites and the Graptolites. His premature decease is a heavy loss to science, the more so as he has left behind him several important works unfinished.

THE death, resulting from a fall from a horse, is announced of Frederick Joy Pirani, lecturer on Natural Philosophy and Logic at Melbourne University. Mr. Pirani was born in Birmingham in 1850, but went to Victoria when a boy, and was there educated. He was an accomplished mathematician, and gave promise of future eminence. He was active in the promotion of science in the Colony. Mr. Pirani was an occasional contributor to our pages.

AT the last general assembly of the Swiss Alpine Club Mr. Whymper was elected honorary member, "in recognition of his having contributed, as few other travellers have done, to the exploration and renown of the Alps."

THE introductory lecture for the present Session at University College in the Faculty of Science and Arts will be given by Prof. Bonney, F.R.S., on Tuesday, October 4, at 3 p.m., in the Botanical Theatre. The subject will be "A Chapter in the Life-history of an Old University," or a sketch of the chief changes, educational and social, at Cambridge during about the last hundred years. The lecture is open to the public without tickets.

MESSRS. SAMPSON LOW AND CO. announce the following books for the forthcoming season:—"The Head Hunters of Borneo: Up the Mahakkam and Down the Barita; also Journeyings in Sumatra," by Carl Bock; "Uganda and the Egyptian Soudan: an Account of Travel in Eastern and Equatorial Africa; including a Residence of Two Years at the Court of King Mtesa, and a Description of the Slave Districts of Bahr-el-Ghazel and Darfour. With a new Map of 1200 miles in these Provinces, numerous Illustrations, and Anthropological, Meteorological, and Geographical Notes," by R. W. Felkin, F.R.G.S., and the Rev. C. T. Wilson, M.A. Oxon., F.R.G.S.; "Magyarland: A Narrative of Travels through the Snowy Carpathians, and Great Alföld of the Magyar," by a Fellow of the Carpathian Society (Diploma of 1881), and author of "The Indian Alps"; "Through Siberia": illustrated with about thirty engravings, two route maps, and photograph of the author, in fishskin costume of the Gilyaks on the Lower Amur, by Henry Lansdell; "Nordenskjöld's Voyage around Asia and Europe: a Popular Account of the North-East Passage of the *Vega*," by Lieut. A. Hovgaard, of the Royal Danish Navy, and Member of the *Vega* Expedition; "South by East: a Descriptive Record of Four Years of Travel in the Less Known Countries and Islands of the Southern and Eastern Hemispheres," by Walter Coote; "Upolu; or, A Paradise of the Gods: being a Description of the Antiquities of the Chief Island of the Samoan Group, with Remarks on the Topography, Ethnology, and History of the Polynesian Islands in general," by the late Handley Bathurst Sterndale, edited and annotated by his brother.

AMONG Messrs. Macmillan and Co.'s announcements of forthcoming books are the following:—"Voyage of the *Vega*," by Adolf Erik Nordenskjöld (with five steel portraits, numerous illustrations, and maps); "Science and Culture, and other Essays," by Prof. Huxley, F.R.S.; Charles Kingsley's "Water Babies" (a new edition, with illustrations by Linley Sambourne); "Origines Celticæ," by Dr. Guest (with maps); "Physics of the Earth's Crust," by Rev. O. Fisher, M.A., F.G.S.; "A Course of Instruction in Zootomy (Vertebrata)," by T. Jeffrey Parker, B.Sc. Lond., Professor of Biology in the University of Otago; "Elementary Lessons in the Science of Agricultural Practice," by Prof. H. Tanner; "Mathematical Papers," by the late W. K. Clifford, M.A., F.R.S., Professor of Applied Mathematics and Mechanics at University College, London; "Text-Book of Geology," by Archibald Geikie, F.R.S., Professor of Geology, &c., in the University of Edinburgh (with illustrations); "A Treatise on Chemistry," by H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., Professors of Chemistry in the Victoria University, Owens College, Manchester (with illustrations): Vol. III. "The Chemistry of the Hydrocarbons and their Derivatives, or Organic Chemistry," Part I.; "Further Steps in the Principles of Agriculture," by Prof. Tanner; "The Organic Method of Studying Languages," by G. Eugène-Fasnacht; "Electricity and Magnetism," by Prof. Silvanus P. Thompson (illustrated).

MR. B. SAMUELSON, M.P., F.R.S., the chairman of the Royal Commission on Technical Instruction, has returned from a visit to Berlin, where, through the courtesy of our Ambassador, Lord Ampthill, he has secured the assistance and co-operation of the German authorities in the collection of preliminary information bearing on the subject of the inquiry. He has also made arrangements for the forthcoming visit of the Commissioners to the manufacturing districts of Westphalia. At the first meeting of the Royal Commission it was resolved that among the points to be examined should be the instruction afforded on the Continent to the proprietors and superior managers, the foremen, and the workpeople engaged in industrial pursuits, and that investigation should also be made into the connection between general and technical instruction, and the sources of the funds from which such instruction is defrayed.

THE last field meeting of the year of the Woolhope Naturalists' Field Club, we learn from the *Gardeners' Chronicle*, will be held at Hereford, on Thursday, October 6, for a foray among the funguses. There will be an exhibition of funguses in the museum room at the Free Library, and an evening meeting will

be held there on Wednesday, October 5, at 8 p.m., to name and study them. The foray will be made in Stoke Edith Park and grounds, by the kind permission of Lady Emily Foley. A meeting of the members will be held in the Woolhope Club-room at 3.45 to elect the officers for the ensuing year, and to transact the ordinary business of the Club. The dinner will take place at the Green Dragon Hotel at 4.30 p.m., and a *soirée* will be held at the house of Mr. Thomas Cam at 8 p.m., to which he kindly invites all who may be present at the meeting. After dinner, or at the evening meetings, papers will be read on the following subjects:—The progress of mycology, by Dr. Bull; fungus mimics, by M. C. Cooke, M.A., LL.D., &c.; the Herefordshire Carices, by the President of the Club; the fungi of the Dolomites, by Thomas Howse, F.L.S., &c.; the fungi which attack the wheat, by the Rev. John E. Vize, M.A.; the germination of the Uredines, and the relationship of *Æcidium berberidis* to *Puccinia graminis*, by Mr. C. B. Plowright; Protococcus, by the Rev. John E. Vize, M.A.; monstrosities in fungi, by W. Phillips, F.L.S., and a curious and abnormal cellar Polyporus will be shown by Mr. Phillips; two tomato diseases, by C. B. Plowright. The Pomona Committee of the Club have decided to hold an exhibition of apples and pears on Wednesday and Thursday, October 26 and 27, and schedules of the prizes offered may be obtained from the hon. secretaries, Woolhope Club-room, Free Library, Hereford.

ALL who have to consult or translate from French scientific and technical works will welcome Dr. F. J. Wershoven's "Technical Vocabulary, English-French, for Scientific, Technical, and Industrial Students" (Hachette and Co.). The vocabulary is arranged according to subjects, beginning with general notions on matter, and going on to force and motion, gravity, and other subjects in physics, mechanics, and chemistry, and their applications, and giving all the words and phrases in use in regular order. An ample alphabetical index renders the vocabulary easy of consultation. There is also an English-German edition.

MR. A. TREVOR CRISPIN, writing from Hyde End House, Brompton, Reading, sends us the the following information:—He is staying with his brother-in-law, Capt. Johnston, and the other morning, as usual, Capt. Johnston had had a cut fluted tumbler brought to his dressing-room filled with milk warm from the cow; into this a small quantity of rum was put, and the whole left standing. While Capt. Johnston was having his bath there was a loud noise, and on looking round he found the tumbler had parted in two, and there was an interval of four or five inches between the two parts. The fracture commences near the top (and the circumference at the top remains unbroken), at the very line of the level of the milk, the mark of which remained quite distinctly on the glass. This was the second occurrence of a precisely similar nature, the first having taken place about a month ago; but then the fracture took place some minutes after the contents of the glass had been consumed.

WE learn from the *Bulletin* of the Physical Observatory at Tiflis, that on August 24, at 11.18 p.m., there was felt in that town an earthquake which consisted of three shocks, direction from north-east to south-west. The same earthquake was felt at Gori at 11.9, at Kutais at 11.40, the direction being from east to west; at the station Kobi of the military route at 11.27, the direction being north-west to south-east; and at Gomi, a station of the Poti and Tiflis railway, where it lasted for about twenty-five seconds.

AN earthquake shock, very slight in this neighbourhood, but stronger further east, was felt in the basin of the Lake of Geneva on Friday. The earthquake was followed by a violent thunderstorm, which seemed to extend from the Alps to the Jura. Several vessels were wrecked and some lives were lost on the Lake of Brienz. A village in the district of Albula is threatened with a disaster similar to that which has just befallen Elm. The village lies at the foot of the Rothorn, a mountain in which there are several deep fissures, a part of which has been actually in movement for some time. Several engineers have already inspected the locality, and the intervention of the Federal and Cantonal Governments is demanded, in order that, if possible, measures may be taken to avert the impending peril.

A SHOCK of earthquake occurred on September 25 at Elmira, State of New York, followed by a destructive hurricane, which was, however, of short duration. On Thursday last, at noon, further shocks of earthquake alarmed the inhabitants of Orsogna, Lanciano, and Castel Frentano, where a landslip did serious damage.

THE Calendar of the Mason College, Birmingham (which has already attained considerable thickness), for the ensuing session contains a very satisfactory programme of the teaching promised by this institution. The session opens on Tuesday next with two introductory addresses, by Prof. R. H. Smith (Civil and Mechanical Engineering), and Prof. Edward Arber (English Literature).

MR. J. W. SWAN, the *Photographic News* states, has entered into an amicable arrangement with Messrs. Siemens Brothers the well-known electricians—they to employ his lamp, and he t use their apparatus. In company, they are to light up the new theatre in Beaufort Buildings with electricity, three hundred of Mr. Swan's lamps being used on the stage and in the auditorium. At the Paris Electrical Exhibition they are making a fuss over the model of a theatre lit up by electricity; in London we shal have the real thing.

M. FERRY, French Minister of Public Instruction, has authorised the opening at Montpellier of the first national college for the education of females.

THE Jamaica Government are offering great advantages to those who are inclined to embark in the cultivation of Cinchona. Suitable land is offered at a very low rate, and it seems to us that, with proper methods and selection of the right kind of plants, there is room in Jamaica for a limited number of plantations of this kind. In connection with this, Mr. D. Morris has issued a valuable series of "Hints and Suggestions for Raising Cinchona plants from seeds, and establishing Cinchona plantations."

"PROFITABLE and Economical Poultry-Keeping," by Mrs. Eliot James, is a useful little work, published by Ward, Lock, and Co.

WE have received the Reports of the Leicester and Nottingham Literary and Philosophical Societies. The former is divided into various science sections, each of which seems efficient. The Leicester Society is printing a record of its early *Transactions*, part vii. extending from June 1860 to June 1865.

A PROPOSITION has just been set on foot for an exhibition of naval and submarine engineering appliances, which is to be held in the early part of next year at the Agricultural Hall, Islington. It is intended to cover the wide field occupied in the production of machinery and mechanical contrivances employed in, or connected with, the construction and equipment of ships of all classes.

MESSRS. GRAS AND CO. of Madrid announce the publication of a Popular Illustrated Encyclopædia of Science and Art, edited by Mr. F. Gillman, mining engineer. It seems to be modelled on the German Conversations lexicon, though, to judge from the

prospectus, the work will be arranged according to subjects, and not alphabetically.

NOWHERE, according to Prof. Porter, President of Queen's College, Belfast, is the vital importance to the nation of technical education more keenly felt than amongst the merchants and manufacturers of Ulster. "Germany" (observes the same authority) "provides buildings, laboratories, and scientific apparatus on the most liberal scale. In France, Belgium, Switzerland, and the United States of America, higher technical education is making rapid strides under the fostering care of the respective Governments, aided by the generous contributions of patriotic citizens. The results of this wise liberality, while enriching those nations, are most seriously affecting the manufacturing interests of this country, and especially of Belfast and Ulster." Prof. Porter considers that in order fully to develop the latent resources of that part of Ireland we must have the means of giving young men a scientific training.

IN the *Bulletin* of the Essex (U.S.) Institute for April, May, and June is a paper by the Rev. G. F. Wright, on the Glacial Phenomena of North America, and their Relation to the question of Man's Antiquity in the Valley of the Delaware.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus radiatus*) from India, presented respectively by Mr. J. Thompson and Mr. C. Green; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. W. Thomson; a Banded Ichneumon (*Herpestes fasciatus*) from West Africa, presented by Mr. W. Cubitt; two Common Otters (*Lutra vulgaris*) from Ross-shire, N.B., presented by Mr. H. Mitchell; a Black-crested Eagle (*Lophoaëtus occipitalis*) from Africa, presented by Mr. E. A. Harland; a Brush Turkey (*Talegalla lathami*) from Australia, presented by Capt. F. M. Burke, s.s. *Cheybassa;* a Red-legged Partridge (*Caccabis rufa*), European, presented by Mr. J. E. Clayton; a Common Cuckoo (*Cuculus canorus*), British, presented by Master Alfred Beart; an American Black Bear (*Ursus americanus*) from North America, deposited; four Zebra Waxbills (*Estrelda subflava*) from Africa, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), three Undulated Grass Parrakeets (*Melopsittacus undulatus*), bred in the Gardens. The additions to the Insectarium include larvæ of the Comma Butterfly (*Vanessa C. album*), scarce Swallow-tail Butterfly (*Papilio podalirius*), and Privet Hawk-Moth (*Sphinx ligustri*). Also imagos of *Ranatra linearis*, and a specimen of *Attacus atlas* reared from larvæ hatched in the House.

OUR ASTRONOMICAL COLUMN

THE SATELLITES OF MARS.—The approaching opposition of this planet does not hold out much probability of satisfactory observations of the satellites except with the larger instruments, though in European latitudes the meridian altitude, which is an element in the case, will be considerable. Taking Prof. Asaph Hall's unit for brightness in 1877, viz. that on October 1, when the outer satellite was seen with the 9·6-inch equatorial of the Naval Observatory, Washington, we find the maximum brightness at the next opposition will be represented by 0·4, which is a less value than corresponds to the last date of observation with the 26-inch refractor at the same observatory. It may be remembered that Mr. Common observed *Deimos* on the morning of September 2, 1879, without much difficulty with his reflector of 3-feet aperture, when the degree of brightness in terms of Prof. Hall's unit was 0·50; at the last Washington observation in 1879 it was 0·52. The earth being only about 10° from the line of nodes of the satellites' orbits at the opposition in December next, their apparent paths are reduced almost to straight lines. The longitude of the ascending node of *Deimos* is 88°.

THE SATELLITES OF SATURN.—Mr. Marth has again prepared ephemerides of the five inner satellites of Saturn, which have been published in the *Astronomische Nachrichten*; he appends differences of right ascension between the outer satellite, *Japetus*, and the centre of Saturn, but he does not attack *Hyperion*. Preceding the ephemerides are auxiliary quantities for every fifth noon at Greenwich, by means of which the positions of the five inner satellites may be determined for any time required from the formulæ—

$$s \sin (p - P) = a \sin (l - L)$$
$$s \cos (p - P) = b \cos (l - L).$$

Here p is the angle of position with reference to the planet's centre, and s the distance therefrom; the values of $(l - L)$ and of the semi-axis a and b are tabulated for each satellite, as well as the angle P, which is applicable to all five. The process is simple enough to any one initiated in such calculations, but as there may be observers to whom they are unfamiliar, an example may not be out of place here.

Let it be required to determine from Mr. Marth's tables the angle of position and distance of *Mimas*, at Greenwich midnight, on October 1. We have then—

$(l - L)$ Oct. 1d. 0h. ...	287°·60	$\log a$	+1·4856
Motion in 12h.	191°·04	$\sin (l - L)$	+9·9433
$l - L$	118°·64	Call the sum A ...	+1·4289
From the tables P =	359°·58	$\log b$	−1·0128
a =	30″·59	$\cos (l - L)$	−9·6806
b =	−10″·30	Call the sum B ...	+0·6934
		$\frac{A}{B} = \tan (p - P)$...	+0·7355
		$p - P$	79°·58
		Add p...	359°·58
		p	79°·16
		$\sin (p - P)$	+9·9928
		$\frac{A}{\sin (p - P)}$	1·4361
		s	27″·30

THE FOURTH COMET OF 1874.—Dr. Holetschek, of the Observatory of Vienna, has investigated definitive elements of this comet, which was discovered on August 19, 1874, by M. Coggia at Marseilles. He uses four normal places: for August 21, September 18, October 10, and November 9. For the later normals we presume he will have made use of a fine series of observations made with Col. Tomline's 10-inch refractor at the Orwell Park Observatory, near Ipswich, by Mr. J. I. Plummer, which extends, we believe, considerably beyond observations published so far from other observatories. With Col. Tomline's refractor the comet was followed until the middle of November, and great care appears to have been taken with the observations and reductions. They form one of the very best series that has obtained for some years at an English observatory. Dr. Holetschek infers that the comet was moving in an elliptic orbit with a period of about 300 years. His orbit is as follows:—

Perihelion Passage, 1874, July 17·68463, Greenwich M.T.

Longitude of perihelion	5 26 13	M. Eq. 1874·0.
,, ascending node ...	215 50 47	
Inclination	34 7 54	
Excentricity	0·9622257	
Log. perihelion distance	0·227275	
Semi-axis major	44·671	
Period of revolution	298·6 years.	

The comet with these elements might approach pretty near to the planet Uranus near the ascending node, but we might rather look to an encounter with Mars at the opposite node as the cause of ellipticity of orbit, the radii-vectores being there identical, with but small difference of latitude.

ANCIENT STAR-POSITIONS.—In the *Vierteljahrsschrift der Astronomische Gesellschaft*, 16 Jahrgang, Dr. O. Danckwortt has tabulated the positions of forty-six fundamental stars of the *Berliner Jahrbuch* for the commencement of each century from −2000 to +1800. He adopts Leverrier's precession constants for 1850, and takes account of the proper motions. The tables are preceded by a discussion of formulæ and comparison of constants which will be of service to any one who may have

occasion to carry back to a distant epoch the place of a star not included in Dr. Danckwortt's list. The values of the arcs A, A', and θ, are given for the beginning of every century within the above period. The place of the present Pole-star for the year −2000 is found to be R.A. 335° 10′ 0″, Decl. +67° 34′ 30″.

WE may mention that the formulæ for the reduction of the places of stars to distant epochs are investigated in a very interesting paper by Prof. Schjellerup, which Dr. Copeland and Mr. Dreyer have translated in No. 2 of *Copernicus*, and which the reader who desires to acquaint himself with the application of the rigorous method of taking account of precession should consult.

PHYSICAL NOTES

THE conducting power of metals for heat and electricity has lately occupied several physicists. Prof. Lorenz of Copenhagen, employing two methods (*Wied. Ann.*, Nos. 7 and 8), gets these results: (1) for the better conducting metals, a confirmation of Wiedemann and Franz's law, that the ratio of the two conductivities, both at 0° and at 100° is nearly constant; in the inferior conductors it increases much with decreasing conductivity; (2) in all metals except iron, the ratio $\frac{k_{100}}{\kappa_{100}} : \frac{k_0}{\kappa_0}$ is constant, and approximately equal to 1·367 (k and κ denoting the conductivities for heat and electricity respectively). Thus, for absolute temperature T, $\frac{k}{\kappa} = T \times$ constant.

A "MEDICAL hydrotelephone," contrived by Prof. Sabatucci (*Riv. Sci. Ind.*) is of the following nature:—Two lead cylinders (5 ctm. in diameter and ½ ctm. thick) are closed each with two very fine iron laminæ. To the anterior part of each is fitted a wooden mouthpiece (like that of a Bell telephone) connected to a caoutchouc tube, through which one may hear at a distance. The posterior part has a very sensitive electromagnet communicating with a microphone and battery. One tube is applied to either ear. Words or sounds produced before the microphone, and heard but faintly, are rendered intense and distinct by introducing liquid into the cylinders (the less dense the liquid the better). Two sounds may be compared, and their intensity exactly measured, by varying the quantity of the liquid and noting the effects through the tubes. Various applications of the apparatus, in clinical medicine especially, are looked for.

THE effects of lightning on trees placed near a telegraph wire are forcibly illustrated by phenomena lately observed by M. Montigny (*Bull. Belg. Acad.*, No. 7) on a portion of the road from Rochefort to Dinant; which runs from east to west, first on level ground and between poplars for about 1500 metres, then rises gradually 61 metres through woods to a wooded plateau some 200 metres in extent, then comes down to another plain. Of the poplars bordering the road on either side those on the north side, next the telegraph line, have largely suffered, 80 out of 500 having been struck, or about a sixth; those on the other side are very rarely struck. The plain presents only one case, and that doubtful. The instances multiply with increased elevation, and in the wooded plateau on the top reach a maximum (64 per cent.). The most violent discharges have been on the west side of the plateau and rising ground, which is generally first reached by the storms, and the injuries to trees are mostly opposite and under the level of the wire. M. Montigny supposes that while the wire is strongly electrified by induction, the lightning does not strike it, on account of its relative insulation, but strikes the neighbouring poplars directly, which, wet with rain, afford an easier passage for the electric fluid to the ground.

M. PICTET has examined seven varieties of steel (chiefly from a Sheffield and a Vienna house) with regard to magnetic power (*Arch. des Sciences*, August 15). This power he finds to depend on the presence of carbon in the iron, and the aggregation of these substances. One of the two steels giving the best results had ⅞th per cent. of carbon. Samples with 1½ and 1¼th per cent. were inferior. German steel of poor quality (for springs) yet made a good magnet; it had little homogeneity, and consisted of an intimate mixture of iron, and iron cemented with a small proportion of carbon. A too-small proportion of carbon suppresses or weakens the remanent magnetism. M. Pictet also finds that the increase of magnetic power in a magnet through the mere presence of the armature in contact is a certain fact for some qualities of steel, but not for all. The first magnetic passes develop nearly the whole of the remanent magnetism in all artificial magnets. Detachment of the armature by the dynamometer seemed to have no action on the magnetic power, only the slipping of the armature when near rupture must be avoided.

AN experimental inquiry into the production of tones by passage of gases through slits is described by Herr Kohlrausch in *Wiedemann's Annalen* (No. 8). The principal results are these: (1) For all widths of slit between 0·2 mm. and 1 mm. and all densities of gas employed, the pitch n may be represented as linear function of the velocity of outflow u by the formula $n = k(u - u_0)$, where u_0 and k are constant for a given width of slit and variety of gas; (2) with increasing width of slit (0·2 mm. to 1 mm.) u_0 decreases, k increases; (3) u_0 and k (for air) are as good as independent of the thickness of the slit (*i.e.* the thickness of the brass plates forming it), from 1 mm. to 9 mm.; (4) with increasing density of gas (0·7 to 1·5) u_0 generally decreases, k increases, *i.e.* the tones, *ceteris paribus*, become higher; (5) u_0 and k depend in no small measure on other properties of gases besides density; (6) starting from wide slits with constant velocity of outflow, the pitch increases pretty uniformly with narrowing of the slit, reaches a maximum with widths between 0·35 mm. and 0·27 mm.—with thicker slits, smaller pressures, and less dense gases, sooner than in the opposite cases—and then decreases more and more quickly with the width of slit; (7) this maximum pitch characteristic for each velocity of outflow occurs with a greater width of slit, the less the velocity. From a comparison with Strouhal's experiments on the tones excited by motion of cylindrical bodies in air, the author concludes that the production of slit-tones is to be referred to like causes to those of wire-tones.

AN electrophotometer recently described by Dr. Nachs (*La Natura*, August 1) has the following arrangement:—A wooden case opening on one side and above is divided into two compartments, an upper and a lower. The lower contains in the inner part a dry pile of 200 elements, and in the outer a Jacobi rheostat, the cylinder of which has thirty windings (the number introduced into circuit by turning a handle is precisely indicated). The upper compartment has interiorly a galvanometer, and exteriorly an adjustable truncated cone with inner surface blackened, and within it a small selenium cell similar to those used by Bell and Tainter, to receive the light. This cell and the three other electrical instruments are connected by wire. The mode of action will be readily comprehended.

MR. MILNE has observed (*Zeits. f. Kryst.*) that if a suspended quartz ball be allowed to impinge in various ways upon a fixed ball of lime spar, or if the ball of lime spar be placed on a billiard table and the distance observed to which it is driven by the shock, in the former case the quartz ball rebounds furthest, and in the latter the lime spar ball is driven furthest, when the impulse is in the direction of the (crystalline) axes.

IN a paper to the Bremen Society of Natural Science, Herr Müller Erzbach describes experiments in which he sought to ascertain the relative tension of aqueous vapour over saturated solutions of different hygroscopic substances, the inclosed air being submitted for long periods to the action of these. 1. For saturated solutions one finds in the same series, soda, potash, chloride of calcium, an increase in the vapour-tensions, and a decrease in the contractions. 2. Phosphoric acid anhydride, concentrated sulphuric acid, and hydrate of potash deprived of water, present no essential difference in attraction of water. 3. Caustic soda and chloride of calcium, with small proportion of water, differ little in attraction of water, but they do not bind it so firmly as phosphoric acid or hydrate of potash. 4. Hydrate of soda can be completely deprived of water by inclosure with hydrate of potash. 5. The difference in tension of aqueous vapour over the anhydride of phosphoric acid and chloride of calcium nearly without water amounts to only a small fraction of a millimetre of mercury.

THE hypothesis that the luminiferous ether is at rest and the earth moves through it, has been lately put to experimental test by Mr. Michaelson of the U.S. Navy (*Amer. Journ. of Science*, August). Two pencils of light which have travelled over paths at right angles (one path being in the direction of the earth's motion) are permitted to interfere. On rotation of the apparatus 90° a measurable displacement, estimated at about one-tenth of the distance between the fringes, might be looked for (the author considered) if the hypothesis of a stationary ether were correct. The apparatus was first tried in the Physical Institute

in Berlin, then, for greater quiet, in the Astrophysicalisches Observatorium at Potsdam (it was very sensitive to vibrations). The interpretation of the results is that there is no displacement of the interference bands, and the hypothesis (which is presupposed in the commonly accepted explanation of aberration) is inferred to be erroneous.

THE expansion of solid sulphur has been studied by S. Scichilone of Palermo, in the case of natural crystals, and of such as had been heated after fusion to 140° and 240°. The tables (*Wied. Beibl.*, No. 7) show that the expansion depends essentially on the previous heating, inasmuch as different modifications of sulphur are thereby formed. In the first case we have the octahedral sulphur, in another the monoclinic, and in the third a mixture of the latter with that which is not dissolved in sulphide of carbon. In the first two cases the curve representing the volumes as a function of the temperature turns its convex side, in the third its concave side, to the axis of temperature.

GEOLOGICAL NOTES

THE recent geological exploration of the shores of Lake Baikal by M. Tchersky has been fruitful of important results for science. The rocks of which the mountains on the western shore are built up belong to three different ages: pre-Silurian (probably Laurentian), Silurian, and Jurassic. The Laurentian rocks afford several foldings running north-east, which enclosed basins of Silurian and Jurassic seas; as to recent formations they are only freshwater ones, and belong to the Tertiary and Post-pliocene; these last, which are remains of several smaller lakes, are found at a great height above the level of Lake Baikal. M. Tchersky's geological researches confirm the suggestion which was made several years ago on geographical grounds by M. Kropotkin, namely, that, like several other lakes, Lake Baikal consists of two longitudinal valleys, connected together in the middle part of the actual basin.

THE important coal-basin of the Don province of Russia has not hitherto been explored with accuracy. During last summer M. Domger undertook a thorough exploration of this interesting geological region, and, as we learn from a communication he has made at the December meeting of the St. Petersburg Mineralogical Society, his researches have led to important discoveries. Thus he discovered a great variety of crystalline rocks, porphyries, &c., and volcanic ores, within the coal-measures, which discovery thus extends the crystalline island of Southern Russia far eastwards as a strip about 500 miles long, which runs from north-west to south-east. At the same meeting the Society awarded its gold medal to M. Romanoffsky for his researches in Turkestan.

M. DOKOUCHAIEFF'S researches on the soils of Russia seem to establish a very interesting fact as to the distribution of black-earth. The typical black-earth occupies an elongated zone directed from south-west to north-east from Kishineff, through Kharkoff, Voronesh, Simbirsk, to Bougoulina in the province of Oufa; in this zone the black-earth contains from 7 to 12 per cent. of humus, and from both sides to north-west and south-east it is accompanied by two other elongated zones, where the black-earth contains only 5 to 7 per cent. of humus, whilst the other parts of Russia afford only sporadic spots of black-earth.

M. MOUSHKETOFF'S paper on the glacier of Zerafshan, which appeared in a recent number of the *Izvestia* of the Russian Geographical Society, contains further details about the expedition which has explored the glacier throughout its whole length, from its lower extremity to the sixteen miles distant and 13,800 feet high pass of Matcha, whence another glacier, that of the Zardala river, descends on the north-eastern slope for 2200 feet, by a series of mighty icefalls. The paper is accompanied with a pretty map which shows this grand ice-world, where no less than thirteen secondary glaciers are feeding the ice-stream of the Zerafshan. We notice in this paper that formerly the Zerafshan glacier descended far lower than now. M. Moushketoff says that thirty-three miles below its actual extremity, namely, at the village Diaminor, there is a beautiful terminal-moraine which crosses the valley and unites with three longitudinal moraines. Immense boulders, thirty-five and forty feet in diameter, and consisting of granite, syenite, and gabbro, cover the whole space between these old moraines and the actual ones, so that there cannot be the least doubt as to the glacier having descended for at least thirty-three miles lower than now. But when we see how the composition of the drift changes lower down in the valley, the loess, which is the wealth of the inhabitants in the lower countries, changing into mighty conglomerates with immense boulders, we are much inclined to think, that the former glaciers descended yet far lower. Therefore we observe with some regret that M. Moushketoff gives too little attention to the diluvial formations of the Upper Zerafshan and to their relations to the loess.

GEOGRAPHICAL NOTES

WHEN Humboldt determined for the first time the average heights of continents, he could not, because of the want of data, determine that of Africa. Now Dr. Chavanne publishes, in the *Proceedings* of the Geographical Society of Vienna (vol. xxiv.), an elaborate paper on this subject, accompanied with a hypsometrical map of the African continent, which is based on no less than 8000 hypsometrical measurements. After a thorough discussion of the relative value of various measurements, Dr. Chavanne discusses the average heights of separate parts of Africa, and by how much each of them would raise the continent if its mass were distributed over the whole of the surface of Africa. He finds that the Atlas Mountains, if distributed over the surface of Africa, would produce an elevation of 26 metres; the Sahara, 122 metres; the plateaux of Soudan, 85 metres; those of Central and South Africa, 129 metres; and so on; and he accepts for the average height of the whole of the continent no less than 661·8 metres (with a probable error of ± 21 metres), which figure he considers to be rather below the truth. This very high figure obviously is the result of the very great extension of high plateaux, which we do not find to such an extent even in Asia.

IN the Annual Report of the Surveyor-General of India, which, though it has been printed for months, has only just been allowed to appear, prominence is given, under the heading of Trans-Frontier Exploration, to an attempt to determine the position of the head-waters of the Irrawaddy by Capt. J. E. Sandeman, through the agency of a native surveyor whom he had trained in imitation of the late Col. T. G. Montgomerie's renowned staff in India. This surveyor alleges that he ascended the river to Mogung-poon, near the point where it divides into two great branches, the Malee and Mehka. The surveyor, we believe, gives as an explanation of his not having prosecuted his journey to a more successful termination, that he was attacked and robbed by wild tribes; but we hear privately that persons in Burma, well qualified to form an opinion, attach little credit to any of the surveyor's statements, and we fear, therefore, that the position of the head-waters of the Irrawaddy is still an unsolved problem.

THE Geographical Society of the Pacific is the title of a new Society formed at San Francisco. The Secretary is C. Mitchell Grant, F.R.G.S. The objects of the Society, it is stated, are to encourage geographical exploration and discovery; to investigate and disseminate geographical information by discussion, lectures, and publications; to establish in the chief city of the Pacific States, for the benefit of commerce, navigation, and the industrial and material interests of the Pacific Slope, a place where the means will be afforded of obtaining accurate information, not only of the countries bordering on the Pacific Ocean, but of every part of the habitable globe; to accumulate a library of the best books on geography, history, and statistics; to make a collection of the most recent maps and charts, especially those which relate to the Pacific coasts, the islands of the Pacific, and the Pacific Ocean; and to enter into correspondence with scientific and learned societies whose objects include or sympathise with geography. The Society will publish a *Bulletin* and an annual *Journal*.

WE learn from the Annual Report for 1880–1881 of the Swiss correspondent of the Geographical Society of Vienna that the following geodetical and geological work was done in Switzerland:—The Geodetical Commission has published the seventh fascicule of the "Nivellement de Précision de la Suisse," which contains the measurements done during the years 1877 to 1879 on the lines of Monte Cenero to Chiasso, Reichenau to Sargans and Andermatt, and Süss to Landquart and Chiavenna, uniting thus the Swiss measurements with the Italian ones. The Geological Commission publishes the fourth volume of its new series, containing the important work, by Dr. Balzer,

on the zone of contact between the gneiss and the limestones of the Berne Oberland; another most interesting work, on the distribution of heat in the interior of the St. Gothard Tunnel, is pursued by Dr. Stapff, and a preliminary notice about it, with maps, has just appeared in the Quarterly Reports of the Federal Council. (vol. vii.). It shows that the temperature of rocks increases to a great degree to the interior of the tunnel, being only 17° Celsius and 19°·7 at the southern and northern extremities of the tunnel, and as high as 30°·8 in the middle parts of it, the decrease at the outer ends being attributed by Dr. Stapff to the cooling influence of the water which circulates in the rocks. As to the geological information collected by Dr. Stapff during his work in the tunnel, which appears complete (with sixty sheets of maps and profiles) in the Reports of the Federal Council, a short *résumé* of the whole has already appeared in a separate fascicule of these Reports, with a geological outline of the tunnel. We notice also in this branch a valuable paper, by M. Salis, on the erosion of the Nolla River, tributary of the Rhine, which has appeared in the engineering paper, *Die Eisenbahn*, published at Zurich.

THE various races which inhabit Austria are studied by Dr. Goehlert in the last number of the *Proceedings* of the Geographical Society at Vienna (vol. xxiv.), with respect to the length of the body. After having collected more than one and a half million of such measurements, which were done on recruits during the years 1870 to 1873, Dr. Goehlert has dressed a map in which he has shown the average height of young men, twenty to twenty-three years old, in Austria. The Dalmatians are the tallest; next to them come the Serbo-Croats and Slovenes, and then the Germans and the Czechs; further down come the Ruthenes and Roumanians, and the smaller ones are the Magyars and Poles, especially the Mazours. But there are also two or three distinct average heights among the Germans, the Slaves, and the Magyars, those of middle Hungary, between the Danube and the Theiss rivers, being far taller than those of the flat country on the left bank of the Theiss. It is most probable, as M. Broca has shown with regard to France, that these notable differences of height among the same race show that there were two, or more, different branches which constituted what we consider now as a single race. As to the supposed decrease of height observed in France, Dr. Goehlert supposes that in Bohemia, which has furnished during this century no less than 600,000 men to the Austrian armies, the decrease of average height can be estimated at little under 39 millimetres during the last hundred years, this decrease being due to the continuous taking away of tall men from the country. He shows also that, the standard height being the same for all provinces of Austria, the provinces where men are taller suffer proportionately more from recruiting.

THE seventeenth meeting of the Swiss Alpine Club was opened at Basel on September 10. The Annual Report shows that since its foundation the Club has built thirty-one huts, or *refuges* for climbers. The Club has also endeavoured to give a certain instruction to guides, and during this year an insurance society has been instituted for them. As to its publications, it has published sixteen volumes of year-books, which contain plenty of valuable information on the Swiss Alps, and publishes two papers, the *Écho des Alpes* and the *Neue Alpenpost*, which have contributed much to the development of Alpine literature. At its last meeting Mr. Ed. Whymper and the meteorologist, Prof. Hamon, were elected Honorary Members.

THAT part of the Ala-taou Mountains which is situated north-east from Tashkent, at the sources of the Arys, Talas, and Pskem Rivers, and which remained until now quite unknown, is described in the *Izvestia* of the Russian Geographical Society (vol. xvii. fascicule 3) by Col. Ivanoff. It is a very complex system of mountains, from 10,000 to 16,000 feet high, covered with mighty glaciers. The upper clefts have still conserved a good deal of forests, and the high Alpine pasturages are the grazing ground for the numerous herds of Kirghizes, as well as for the great species of *Ovis*, common to Thian-Shan. Col. Ivanoff has found numerous proofs that formerly the glaciers had a greater extension than now, and that they formed in the valley of the Maydan-tal River a mighty glacier which descended as low as 7000 feet, but he did not discover traces of a general glaciation.

HERR ERNST MARNO gives, in the last fascicule of the *Memoirs* of the Geographical Society of Vienna (vol. xxiv. Nos. 6, 7, 8, and 9), an interesting description of his expedition for the destruction of the *setts* of the Nile, that is, of the great grass-islands which are formed during the inundations of the steppes watered by the Bahr-el-Gebel and the Bahr-el-Abiad. The accumulation of grass which is driven away during the inundations constitutes, as is known, wide grass-islands, or *setts*, which bar up the river, and, when not cut through for several years, gradually increase by fresh grass and slime, and soon constitute true floating islands twelve and fifteen feet thick, which soon reach even the bottom of the river. It is with the greatest difficulty that Marno's steamer cut passages through these islands and destroyed the smaller ones.

WE see with pleasure that the Austrian Tourists' Club, which numbers as many as 300 members, has begun to publish fortnightly a *Tourists' Newspaper*, richly illustrated, which has as contributors many well-known scientific writers.

IN the *Monatsschrift für den Orient* for September, Herr von Schweiger-Lerchenfeld has a long article full of valuable information on Tripolitania, *à propos* of recent doings in North Africa. There is also an interesting letter from Ernst Marno on the Sudan.

IN the *Bulletin* of the Antwerp Geographical Society (tome vi. 3e fasc.) M. L. Delavaud has brought together a number of valuable notes on the climate of Africa, interesting both from a scientific and a practical point of view.

THE last number of the *Izvestia* of the Russian Geographical Society contains papers, by M. Maeff, on the roads leading from Karshi to the Amu-daria River, and on the valleys of Vaksh and Kafirnahan; by M. Ivanoff on the upper parts of the Talas Alataou, and a map showing M. Mikluho-Maclay's travels in the Melanesian Islands.

THE eighth volume of the *Memoirs* of the Russian Geographical Society, for the section of ethnography, contains several valuable papers on the middle parts of the valley of Zerafshan, on the basin of Lob-nor, on the valley of Ferghana, on the Bekdons Shahrisabs, on the journey of Jenkinson to Khiva in 1559, on the Khiku-nor, and on the customs of the Tartars of Kazan.

IN a pamphlet entitled "Geography" Messrs. Ramsey, Millett, and Hudson have reprinted, from the Kansas City *Review of Science and Industry*, an interesting collection of official documents relating to United States Arctic colonisation and exploration in 1881. There are now no less than six expeditions in progress under Government control, which are divisible into two classes, one comprising those sent out for purposes of exploration and scientific research and the other those whose object is of a humanitarian nature. To the former class belong the *Jeannette*, Lady Franklin Bay, and Point Barrow expeditions, while the latter includes the *Rodfars*, *Alliance*, and *Corwin*, all chiefly engaged in searching for the *Jeannette* and missing whale-ships.

The just published *Bulletin* of the Belgian Geographical Society includes a paper by Capt. Verstraete on the great lakes of inter-tropical Africa from the fifteenth to the nineteenth century. There are also maps of Borneo, the new northern frontier of Greece, &c., which exhibit considerable roughness of execution.

ECONOMICS AND STATISTICS, VIEWED FROM THE STANDPOINT OF THE PRELIMINARY SCIENCES[1]

THE object of the present paper is to show the relation of the preliminary sciences to statistics and economics, and to attempt to make the transition from the former studies to the latter simple and attractive to the scientific man. This must evidently be done by constructing a classification of social knowledge avoiding all immediate reference to practice. That such a classification does not at present exist cannot be better evidenced than by Mr. Baden-Powell, who has kindly drawn my attention to the conclusion of his paper, read on the previous day, "On Protection in Young Communities," in which he states the difficulties he has encountered in many departments of his researches because of the different methods of classification adopted in otherwise excellent statistical records, and insists that "uniformity in the method of registering statistical facts is of the utmost importance to comparative investigations," so that

[1] Abstract of a paper read before Section F of the British Association, 1881, by P. Geddes, F.R.S.E.

"it would be of great importance if such uniformity could be secured in the future."

A survey of the statistical records of various countries, whether under the same or different political rule, shows the most extreme discord, while a detailed examination of the schemes which have been as yet proposed by statisticians results in their rejection as unscientific—the very latest of such schemes being curiously analogous to the very earliest of classificatory attempts in biology. A criticism of the innumerable definitions of statistics, some of which claim statistics as a science, others as a method, others as both or neither, leads to the acceptance of the view recently sustained by Hooper (J.S.S. 1881), that statistics is simply a quantitative record of the observed facts or relations in any branch of science,—a definition which may conveniently be extended diagrammatically as follows :—

RECORD OF FACTS AT GIVEN TIME.

Qualitative	Quantitative			
	Numerical	Linear	Plane	Solid
		Graphic		
Statements.	Statistics.			

By combining such successive records we obtain history, and statistics and history are thus seen to be, within certain limits, the common property of the sciences—all save logic, where there are no ideas of quantity, being statistical, and all save logic, mathematics, physics, and chemistry, where conditions and properties are constant, being historical; the current notions of statistics and history as distinct sciences, or as distinct scientific methods, being therefore entirely erroneous.

The application of the above diagrammatic definition of statistics to all the sciences clearly illustrates the continual progress from qualitative to quantitative knowledge which goes on in each, and the increase of definiteness which quantitative knowledge constantly tends to assume. Thus while the common name of a chemical compound, say sulphate of iron, expresses only a qualitative relation, its ordinary chemical formula, $FeSO_4$, reaches the numerical state, and its graphic and glyptic formulæ are respectively the plane and solid representations of the same relation of quantity. So, too, the astronomer has his star maps and orrery, the biologist his figures and diagrams, while the sociologist so often requires similar aid that the French Government has recently established a Bureau de Statistique Graphique. So by piling up successive graphical representations of statistical observations, a solid historical model might often be constructed. A geologist, for instance, by piling map upon map of a given island at successive times (the margin being, of course, cut away) would thus construct a solid model which would graphically exhibit the changes of increase and decrease, local and general, throughout the entire period.

But what are the desiderata of a system of classification? It must be natural, not artificial,—capable of complete generalisation and specialisation, universal in application, simple of understanding, and convenient in use. Immeasurably the highest example of such a classification is presented by botany and zoology, and it is therefore the biologist, not the logician or the mathematician, and still less the metaphysician or the political economist, whose training prepares him to undertake the still vaster task of classifying the infinitely numerous and varied phenomena of society.

Taking an actual compendium of miscellaneous statistics, we have first then to separate out in order the actual statistics of the preliminary sciences, mathematical, physical, chemical, astronomical, geological, &c., and leave these to their special cultivators. Social statistics now alone remain, and to classify these naturally we must ascertain the fundamental scientific truths respecting society. Just as the biologist is accustomed to classify man along with inferior organisms, and to trace the fundamental resemblances in structure and function which his organisation presents to theirs, so he must inquire wherein human society resembles the societies formed by the lower animals, the more so as no one disputes that these fall strictly within his province (see Huxley, "Anat. Invert." p. 1). As the term indeed assumes, some general truths must be common to societies of *Formica*, *Apis*, *Castor*, and *Homo* alike, and this must therefore underlie our classification of social facts.

First, then, a society obviously exists within certain limits of space and time. It consists of living organisms. Again, these modify surrounding nature, primarily by seizing part of its matter and energy. Again, they apply this matter and energy to the maintenance of their life; *i.e.* the support of their physiological functions. Finally, these organisms are modified by their environment.

These *sociological axioms*, as we may henceforth term them, at once enable us to classify out the facts relating to each and every society as follows: (A) those relating to the limits of time and space occupied by the society; (B) those relating to the matter and energy utilised by the society; (C) those relating to the organisms composing the society; (D) those relating to the application of the utilised matter and energy by the given society; (E) those relating to the results of the preceding conditions upon the organisms. These considerations were developed in a series of tables exhibited as diagrams upon the wall; and an extremely condensed summary is given on the following page.

These tables, which may be read either separately, in horizontal, or in vertical series (the left-hand vertical series being viewed as entries on the creditor side of a balance sheet), were developed into detail, and shown to be applicable to all societies alike, whether animal or human, civilised or savage, and to include the facts (A) of political geography; (B) of economic physics, geology, botany, and zoology, of technology and the fine arts, transport and commerce, in short, of the economics of production; (C) of anthropology, together with the Registrar-General's reports and the census; (D) of distribution and consumption; (E) of a large body of observations made by physicians, biologists, educationists, and philanthropists dealing with the modifications of the organisms by their environment. These tables, therefore, while endeavouring to classify all known statistics, attempt nothing short of an organisation of the social sciences into a more definite and coherent body of knowledge than they have formed heretofore.

It was then shown that while the above outlined considerations are in entire harmony with the economic labours of the geographer, the physicist, the biologist, the anthropologist, and the demographer, they furnish grounds for a destructive criticism of the existent systems of political economy, in so far as these pretend to intellectual completeness;, the best proof of this being their applicability to utilise and reconcile the labours of each and all the contending schools, statistical and economical alike.[1]

The application of the conceptions of physics and biology to the interpretation of social facts was then alluded to, interest on money being taken as an example. This was shown to depend neither upon compensation for risk of loss, reward for abstinence, nor wages of superintendence, as asserted by economists (Fawcett, "Pol. Econ."), nor yet to be simply an abstraction from the wealth of other members of the community as supposed by its opponents, but usually to arise, in modern times at least, from the appropriation of the matter and energy of nature, and generally speaking, from the exploitation of the sun.

But the severest test which can be imagined is to apply the ideas of the present paper to the study and classification of all the other papers read during the meeting of the section, since no preparation within such short limits of time has been possible. The first, "On Societies of Commercial Geography," relates to the study of territory (Tables A); the second, "Corn or Cattle," in the language of Table B, I., inquires whether the exploitation of plants or animals be more profitable in the given society; the third, "Report of Committee on Teaching," &c., relates to the state and treatment of cerebral functions of certain organisms in the given society; the fourth, "On Agricultural Statistics and Prospects," is at once classified with the second; the fifth, "A General Banking Law," &c., relates to the co-ordination of commerce (Table B, II., Movement), and so on.

So, too, with the anthropological papers :—the first, "Report on Caves and Kitchen-Middens," is a statement of facts respecting production, partition, and consumption in some ancient community, while the next, "On the Stature of the Inhabitants of Hungary," supplies facts to be classified under Hungary, organisms, structure. Nor are the other sections behind in furnishing

[1] The preceding propositions and tables are abridged from the author's paper "On the Classification of Statistics and its Results" ("Proc. Roy. Soc. Edin." 1881).

CLASSIFICATION OF STATISTICS. Society ..... Date .....

A.—Territory. I. Quantitative.			Territory. II. Qualitative.			Territory. III. Decrease.	
Existent at last recorded time.	Increase.		Unused.	Used.		By social agency.	By geologic agency.
	By social agency.	By geologic agency.		Unspecialised.	Specialised.		

B.—Production. I. α. Sources of energy in territory.						II. Development of ultimate Products.			III. Loss. (Premature dissipation of energy and disintegration of matter.)	
Primitive chemical affinity.	Earth's internal heat.	Earth's rotation.	Solar radiation.			Energy.	Exploitation, manufacture, and movement (trade and transport).	Ultimate products.	Agency.	In
			Kinetic.	Potential.					Physical, Biological, Social.	Exploitation, manufacture, movement, remedial effort, &c.
				Earth's crust.	Organisms.	See Table I. α.				
β. Sources of matter used for other properties.						Matter.				
Mineral.	Vegetable.	Animal.				See Table I. β.				

C.—Organisms. I. Quantitative.			Organisms. II. Qualitative.			Organisms. III. Decrease.	
Existent at last recorded time.	Increase.		Biological.		Social.	Emigration.	Death.
	Immigration.	Birth.	Structure.	Function.	Mutual relations.		

C.—Organisms. Occupations. I. (Operations on matter and energy.)			Occupations. II. Direct services to organisms.			Occupations. III.			
Exploitation.	Manufacture.	Movement.	Of non-cerebral functns.	Of cerebral functions.	Of co-ordination.	Unemployed.	Disabled.	Destructive.	Remedial.

D.—Partition (mediate and ultimate) to Class I.			Partition to Class II.			Partition to Class III.			

D.—Use by Class I.			Use by Class II.			Use by Class III.			

E.—Result to Class I.			Result to Class II.			Result to Class III.			

papers essentially economic: witness the numerous interesting papers read to Sections A and G, on the applications of electric energy, and, best of all, the presidential addresses to those sections, of which both were devoted to economic physics, or rather, as the subject should be called, physical economics.

Finally, if the preceding axioms and the soundness of the above classification of social facts be not disproved, it follows that three out of the four great reforms demanded in Mr. Ingram's presidential address,[1] and repeated and enforced in Mr. Grant Duff's, are here introduced into the conduct of economic research, namely, "(1) that the study of the economic phenomena of society ought to be systematically combined with that of the other aspects of social existence; (2) that the excessive tendency to abstraction and to unreal simplifications should be checked; (3) that the *à priori* deductive method should be changed for the historical; while the fourth, that economic laws and the practical prescriptions founded on these should be conceived and expressed in a less absolute form," would readily also be exemplified if the limits of the present paper permitted reference to generalisation and to practice. Again, it is sufficient to quote Mr. Ingram's concluding proposals to show that these have been substantially adopted. The field of the section should be enlarged so as to comprehend the whole of sociology, "since the economic facts of society . . . cannot be scientifically considered apart, and there is no reason why the researches of Sir Henry Maine or Mr. Spencer should not be as much at home here as those of Mr. Fawcett or Prof. Price. Many of the subjects, too, at present included in the artificial assemblage of heterogeneous inquiries known by the name of anthropology really connect themselves with the laws of social development, and if our section bore the title of the sociological, the studies of Mr. Tylor and Sir John Lubbock would find in it their most appropriate place. I prefer the name sociology to that of social science."[2]

THE PROPER PROPORTIONS OF RESISTANCE IN THE WORKING COILS, THE ELECTRO-MAGNETS, AND THE EXTERNAL CIRCUITS OF DYNAMOS[3]

FOR the electro-magnet;
Let L be the length of the wire,
B ,, bulk of the whole space occupied by wire and insulation,
n ,, ratio of this whole space to the bulk of the copper alone (that is, let $\frac{1}{n}B$ the bulk of the copper),
A ,, the sectional area of wire and insulator,
R ,, the resistance of the wire.

For the working coil, let the corresponding quantities be L', B', n', R'. Lastly, let s be the specific resistance of the copper. We have—

$$B = A\,L$$

$$R = ns\frac{L}{A} = ns\frac{B}{A^2}.$$

Hence, $$A = \frac{\sqrt{(nsB)}}{\sqrt{R}} = \frac{K}{\sqrt{R}} \quad . \quad . \quad . \quad (1)$$

and similarly, $$A' = \frac{\sqrt{(n's'B')}}{\sqrt{R'}} = \frac{K'}{\sqrt{R'}} \quad . \quad . \quad . \quad (2)$$

where K and K' denote constants.

Now, let c be the current through the magnet coil, and c' that through the working coil, and let v be the velocity of any chosen point of the working coil. Denoting by p the average electromotive force between the two ends of the working coil, we have—

$$p = I\frac{c}{A}\frac{1}{A'}v. \quad . \quad . \quad . \quad (3)$$

where I is a quantity depending on the forms, magnitudes, and relative positions of B and B', and on the magnetic susceptibility of iron; diminishing as the susceptibility diminishes with increased strength of current, or with any change of R and R' which gives increase of magnetising force.

In the single-circuit dynamo (that is, the ordinary dynamo) c' is equal to c, but not so in the shunt-dynamo. In each, the whole electric activity (that is, the rate of doing work) is pc'; or, by (3)—

$$I\frac{cc'}{AA'}v \quad . \quad . \quad . \quad . \quad (4)$$

or, by (1) and (2)—

$$\frac{I\sqrt{(RR')}cc'v}{KK'} \quad . \quad . \quad . \quad . \quad (5)$$

Of this whole work, the proportions which go to waste in heating the coils and to work in the external circuit are—

$$Rc^2 + R'c'^2 \quad . \quad . \text{ waste} \quad . \quad (6)$$

$$\frac{I\sqrt{(RR')}cc'v}{KK'} - (Rc^2 + R'c'^2). \text{ useful work} \quad (7)$$

By making v sufficiently great, the ratio of (6) to (7) (waste to useful work) may be made as small as we please. Our question is, how ought R and R' to be proportioned to make the ratio of waste to work a minimum, with any given speed? or, which comes to the same thing, to make the speed required for a given ratio of work to waste a minimum? To answer it, let r be the ratio of the whole work to the waste. We have, by (5) and (6)—

$$r = \frac{I\sqrt{(RR')}cc'}{Rc^2 + R'c'^2}\frac{v}{KK'} \quad . \quad . \quad (8)$$

For the single-circuit dynamo we have $c = c'$, and (8) becomes—

$$r = \frac{I\sqrt{(RR')}}{R + R'}\frac{v}{KK'} \quad . \quad . \quad . \quad (9)$$

or $$r = \frac{I\sqrt{\{R(S-R)\}}v}{SKK'} \quad . \quad . \quad . \quad (10)$$

where $$S = R + R' \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Suppose now S to be given, and suppose for a moment I to be constant. The problem of making r a maximum with v given, or v a minimum with r given, requires simply that $R(S-R)$ be a maximum; which it is when $R = \frac{1}{2}S$, that is, when the resistances in the working coil and the electro-magnet are equal. But in reality I is not constant; it diminishes with increase of the magnetising force. As it generally depends chiefly on the soft iron of the electro-magnet, and comparatively but little on the soft iron of the moving armature, or on iron magnetised by the current through the moving coils, it will generally be the case that I will, *cæteris paribus*, be diminished by increasing R and diminishing R'. Hence the maximum of r/v is shown by (10) to require R' to be somewhat greater than $\frac{1}{2}S$: how much greater we cannot find from the formula, without knowing the law of the variation of I.

Experience and natural selection seem to have led in most of the ordinary dynamos, as now made, to the resistance in the electro-magnet being somewhat less than the resistance in the working coil, which is in accordance with the preceding theory.

Whether the useful work of the dynamo be light-giving, or power, or heating, or electro-metallurgy, we may, for simplicity, reckon it in any possible case by referring to the convenient standard case of a current through a conductor of given resistance E connecting the working terminals of the dynamo. This conductor, in accordance with general usage, I call the "external circuit," which is an abbreviation for the part of the whole circuit which is external to the dynamo. In the case of the single-circuit dynamo the current in the external circle is equal to that through the working coil and electro-magnet, or c of our notation. Hence, by Ohm's law—

$$c = \frac{p}{E + R + R'} \quad . \quad . \quad . \quad . \quad (12)$$

or, by (3), (1), and (2),

$$c = c\frac{I\sqrt{(RR')}v}{KK'(E + R + R')} \quad . \quad . \quad (13)$$

Hence either $$c = O \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

or $$I = \frac{KK'(E + R + R')}{\sqrt{(RR')}v} \quad . \quad . \quad (15)$$

The case of $c = O$ is that in which

$$v < \frac{KK'(E + R + R')}{I_0\sqrt{(RR')}} \quad . \quad . \quad (16)$$

where I_0 denotes the value of I for $c = O$. To understand it, remember we are supposing no residual magnetism. For any speed subject to (16), the dynamo produces no current. When this limit is exceeded the electric equilibrium in the circuit becomes unstable; an infinitesimal current started in either direction rises rapidly in strength, till it is limited by equation (15), through the diminution of I, which it produces. Thus,

[1] "On the Present Position and Prospects of Political Economy" (British Association, Dublin, 1878).
[2] Quoted by Mr. Grant Duff, Presidential Address to Section F, 1881.
[3] Paper read at the British Association, York, 1881, by Sir William Thomson, F.R.S.

regarding I as a function of c, we have in (15) the equation mathematically expressing the strength of the current maintained by the dynamo when its regular action is reached. Using (15) in (10) we find—

$$r = \frac{E + S}{S} \quad . \quad . \quad . \quad . \quad . \quad (17)$$

which we all knew forty years ago from Joule.

In the shunt-dynamo the whole current, c', of the working coil branches into two streams, c through the electro-magnet, and $c' - c$ through the external circuit, whose strengths are inversely as the resistances of their channels. Still calling the resistance of the external circuit E, we therefore have—

$$c\,R = (c' - c)\,E, \text{ which gives } c = \frac{E}{R + E}\,c' \quad . \quad (18)$$

Hence, by Joule's original law, the expenditures of work per unit of time in the three channels are respectively

$$\left.\begin{aligned} &R'c'^2 \quad . \quad . \quad . \quad . \text{ working coil} \\ &R\left(\frac{E}{R+E}\right)^2 c'^2 \quad . \quad . \text{ electro-magnet} \\ &E\left(\frac{R}{R+E}\right)^2 c'^2 \quad . \quad . \text{ external circuit} \end{aligned}\right\} \quad . \quad (19)$$

Hence, denoting as above by r the ratio of the whole work to the work developed in the external circuit, we have—

$$r = \frac{R' + R\left(\frac{E}{R+E}\right)^2 + E\left(\frac{R}{R+E}\right)^2}{E\left(\frac{R}{R+E}\right)^2} \quad . \quad (20)$$

$$\left.\begin{aligned} \text{whence} \quad R^2 r &= R'\frac{(R+E)^2}{E} + R(R+E) \\ &= \frac{R'R^2}{E} + (R + R')E + R(2R' + R) \end{aligned}\right\} \quad (21)$$

Suppose now R and R' given, and E to be found; to make r a minimum. The solution is—

$$E = \sqrt{\frac{R'R^2}{R + R'}} \quad . \quad . \quad . \quad . \quad . \quad (22)$$

and this makes

$$r = 2\sqrt{\frac{R'(R + R')}{R^2}} + \frac{2R' + R}{R} \quad . \quad . \quad (23)$$

Put now

$$\frac{R'}{R} = e \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (24)$$

(22) and (23) become

$$E = \sqrt{\frac{RR'}{1 + e}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (35)$$

and

$$r = 1 + 2\sqrt{\{e(1 + e)\}} + 2e \quad . \quad . \quad . \quad (26)$$

For good economy r must be but little greater than unity; hence e must be very small, and therefore *approximately*

$$\left.\begin{aligned} E &= \sqrt{(RR')} \\ \text{and} \quad r &= 1 + 2\sqrt{e} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (25)$$

For example, suppose the resistance of the electro-magnet to be 400 times the resistance of the working coil—that is $e = 400$—and we have, approximately,

$$E = 20R', \text{ and } r = 1 + \tfrac{1}{10}.$$

That is to say, the resistance in the external circuit is twenty times the resistance of the working coil, and the useful work in the external circuit is approximately $\frac{1}{11}$ of that lost in heating the wire in the dynamo.

FUNCTIONAL METAMORPHOSIS OF MUSCLES[1]

THERE is no system in the animal body to which the axiom of Guérin, viz., that "function makes the organ," applies with greater force than to the muscular system. Every student of comparative myology knows that according to the use required of a muscle we have alterations in its volume and connections, or indeed its total disappearance, should its further services in the animal economy be dispensed with. These are the factors which render muscular homologies in many cases so difficult to determine. There is one change, however, which is much more common than is generally believed, viz., the transformation of a muscle into fibrous tissue, or, in other words, its replacement by a ligamentous structure possessing attachments similar to those of its muscular ancestor. It might almost be laid down as a law that whenever a muscle ceases to be of use for contractile purposes, and when, from its attachments, it might be of service as a ligament, that it gradually in course of time becomes transformed into fibrous tissue, and is handed down to posterity in this condition. Indeed should it merely be a case of comparative value, and should the balance of utility be in favour of a ligament, then also will this metamorphosis in all probability take place. Of all adaptations in the muscular system this is perhaps the most beautiful, and instances of it are by no means rare. Thus, in the feet of the armadillo, orycteropus, pig, walrus, and several other animals, certain of the intrinsic pedal muscles have become fibrous bands, indubitably retained for some definite purpose, although their obvious function is often obscure. The most striking examples of this, however, are to be found in the feet of the horse, ox, sheep, camel, and their allies. In these we are able not only to demonstrate with the utmost precision the particular muscles that have become ligamentous, but also the process by which the change has been brought about, and the *rationale* of the transformation.

The *suspensory ligament of the fetlock* in the horse is an exceedingly powerful structure, which lies in the sole of the foot (*i.e.* upon the posterior aspect of the metatarsal bone) under cover of the flexor tendons. It plays an important part in the mechanism of the limb. Its attachments are such that it prevents over extension at the fetlock or metatarso-phalangeal joint, and its value in this respect is evidenced by the fact that when it is ruptured the horse becomes what is termed by veterinary surgeons "broken down." In this condition the fetlock joint sinks downwards towards the ground, whilst the hoof is tilted forwards and upwards.

This ligament is admitted on all hands to be derived from the intrinsic pedal muscles by a transformation of the muscular elements into fibrous tissue; indeed it bears its history written upon its face. Almost invariably a narrow streak of striated muscular fibres can be detected upon its superficial surface which points to its muscular origin. Upon its deep surface fleshy fibres in greater abundance are observed, but these are very pale, owing to a large admixture of fatty tissue.

The question now comes to be—Which of the intrinsic pedal muscles have entered into the formation of this ligament? In making this inquiry we have to keep two points in view: (1) that in the horse the middle or third digit is alone fully developed; and (2) that in a typical pentadactylous foot this digit is supplied by three intrinsic muscles, viz.: a two-headed flexor brevis, and two abductors or dorsal interossei (the second and third) inserted one upon either side of the digit. It is reasonable to conclude, therefore, that the suspensory ligament of the fetlock is derived from one or more of these muscles. But independent remnants of the two dorsal interossei are present, in addition to the ligament, which clearly proves the *flexor brevis medii* to be the source of this structure.

The dorsal interossei in the foot of the horse are of peculiar interest. They are so minute that they can exercise little or no influence upon the movements of the pes. They are simply to be regarded as vestiges of former greatness, and as pointing to retrograde development. They undoubtedly constitute a link in the soft parts between our modern monodactylous horse and its three-toed ancestor. They lead us back to a time when in the foot of this animal there were two distinct interosseous spaces, each filled by a well-marked interosseous muscle.

Still stronger evidence that the suspensory ligament originates solely from the *flexor brevis* of the middle digit is obtained by making thin transverse sections through its substance. We then observe that the sparse remains of muscular tissue are not confined to the surface of the structure, but penetrate into its midst. When the specimen is held against a dark ground, two crescentic opaque outlines are noticed lying side by side in its substance. These undoubtedly represent tracings of the two heads of the flexor brevis, out of which the ligament is developed. On subjecting the outlines to microscopic examination, we find that they are mainly composed of muscular fibres, but every here and there the continuity of this tissue is broken by fatty tissue, in which are observed transversely-divided nerves and blood-vessels.

In the ox, sheep, and camel the suspensory ligament performs the same office as in the horse. The presence, however, of two digits (the middle and annular) complicates somewhat its inferior attachments, in order that it may operate so as to prevent over-extension at both metatarso-phalangeal joints. In each of these animals the structure is undoubtedly formed by the two heads of

[1] Abstract of paper read at the York meeting of the British Association, by D. J. Cunningham, M.D., F.R.S.E., Senior Demonstrator of Anatomy, University of Edinburgh.

two muscles, viz., the *flexor brevis annularis* and the *flexor brevis medii*. Transverse sections of the ligament render this very evident.

In the suspensory ligament of the ox a considerable amount of muscular tissue is found upon both surfaces, and the transverse sections show that this penetrates into its substance in the form of four circular outlines which lie side by side. The fleshy fibres are more abundant than in the case of the horse, but still a considerable amount of fatty tissue enters into the construction of the outlines, and in this are placed nerves and blood-vessels. These four outlines are the remains of the four fleshy bellies of the two flexores breves which amalgamate and transform so as to constitute the ligament.

In the sheep not a trace of muscular tissue is to be found, either on the surface or in the interior of the ligament. The four circular outlines are seen on transverse section, however, but they are entirely formed of fatty tissue. What is of peculiar interest in this case is that in this fat the nerves and blood-vessels are still present.

The camel which the author had an opportunity of examining was a very young specimen, and its foot had been prepared by a fine gelatine and carmine injection. This in some measure obscured the intimate structure of the suspensory ligament. Not a trace of muscular tissue or fatty tissue could be detected either on its surface or in its substance. So complete was its transformation that not a single clue to its origin could be discovered. It is quite possible however that in a fresh uninjected specimen traces might be detected.

The suspensory ligament in these animals has undoubtedly been called into existence by the need for such a structure in the foot, and by the comparatively small value of the intrinsic muscles from which it is developed. The intrinsic muscles of the hand and foot have as their function the production of the more rapid and precise movements of the digits. In the animals which possess a suspensory ligament such a function is of no importance, whereas a powerful brace to provide against over-extension at the metatarso-phalangeal joints is an absolute essential.

But the study of the suspensory ligament of the fetlock suggests other interesting points: 1. The process of transformation of muscle to ligament appears to be effected by a fatty degeneration of the muscular fibres with a coincident multiplication of the connective tissue elements. Here, therefore, is what is usually regarded a pathological change assisting a morphological process. 2. The nerves of supply to the muscles are apparently unaffected by the change. In the sheep, in which there is not a trace of muscular tissue, they are seen in the substance of the ligament of a size relatively as great as in the ox or horse. 3. The presence of muscular tissue, where from its small amount it cannot possibly exercise any appreciable function, is peculiar. To account for its continuous existence we must of course suppose that it remains in a state of tonic contraction. The continuance of nerves in the ligament will enable it to maintain this condition.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 12.—M. Wurtz in the chair.—The following papers were read:—Remarks on a memoir of MM. Lœwy and Perigaud on flexure of telescopes, by M. Villarceau.—On the comparative qualities of water of the Isère and of the Durance, as regards irrigation and provision of soil, by M. de Gasparin. He compared the constitution of the liquids at points where all the affluents were united, and at different epochs. The two rivers are closely alike as to the quality of the slime they deposit, that of the Isère being only a little more argillaceous (which slightly favours the state of suspension). Now the Durance is largely utilised for irrigation, and enriches the departments of Bouches-du-Rhône and Vaucluse especially with fertile soil; and it is suggested that a like benefit should be derived from the Isère, in Isère and Drôme.—On a new mode of exploitation of mines of sulphur, by MM. de la Tour du Breuil. They apply the principle of raising the boiling point of water by means of a dissolved salt. Chloride of calcium is so used; the bath containing 66 per cent. of it. The apparatus consists of two rectangular vessels coupled and inclined. When the operation is terminated in one, the boiling liquid is directed into the other, which is previously filled with ore. While liquation is going on (which takes about two hours) the first vessel is emptied and re-charged. One furnace suffices. The sulphur produced is very cheap (about five francs a ton) and pure. Fusion is possible all the year, as no sulphurous acid is produced; and the extraction is very complete.—The Secretary called attention to the subscription opened for a statue to Lakanal at Foix (Ariège).—On radiophony produced by lampblack, by M. Mercadier. Not only is lampblack the best thermophonic agent at present, but it is susceptible, like selenium, of playing the *rôle* of the electric photophone. Instead of selenising one of the faces of his metallic double-spiral receivers, M. Mercadier covers it with lampblack, and they give good effects with intermittent solar, electric-light, and even gas, radiations. When exposed in dark to a copper plate gradually heated with an oxyhydrogen blowpipe, no sound is heard in the telephone till the plate is raised to a dull red; then it gradually increases in intensity. The author is disposed to consider the phenomenon *photophonic* rather than *actinophonic*. The resistance of these receivers diminishes as the temperature rises (from 2° or 3° to 50°), and the variation (very small) is represented nearly by a straight line.—Explanation of a contrast in double circular refraction, by M. Croullebois.—On the magnetic metalls, by M. Gaiffe. He experimented with nickel and cobalt, obtained electro-chemically and variously treated before magnetising; some bars being kept hard, others annealed, and others annealed and forged. The figures show what a comparatively great coercitive force these metals (and especially cobalt), may acquire in a pure state, while pure iron, obtained by the same means, gives inappreciable deflections in the magnetometer. The annealed and forged samples produced the greatest effects (the annealed coming next). The weak coercitive force of the metals on issuing from the galvanoplastic bath, is attributed to the presence of hydrogen in combination with them.—On metaldehyde, by MM. Henriot and Oeconomoides.—On the rotatory power of albuminoid substances of blood-serum, and their determination by circumpolarisation, by M. Fredericq.—On permanganate of potash employed as antidote to the poison of serpents, by M. de Lacerda. A solution of snake poison having been injected subcutaneously under the thigh of a dog, and a 1 per cent. solution of permanganate of potash a few minutes after, the latter prevented all local lesion (abscess, &c.); there was merely a very slight swelling. In other cases of injection into the veins the permanganate proved a powerful antidote.—M. Maumené communicated accounts of a new apparatus for fractional distillation, and of one for measuring the alcoholic richness of mixtures of alcohol and water.

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