THURSDAY, SEPTEMBER 19, 1878

THE LINKS OF THE ANIMAL WORLD

Les Enchaînements du Monde Animal dans les Temps Géologiques, Mammifères, Tertiares. Par Albert Gaudry. 8vo. (Paris: F. Savy, 1878.)

UNDER this poetic title Prof. Gaudry has added one more to his valuable works on the fossil mammalia of the Tertiary Period. Some sixteen years ago he carried on the explorations on the classic ground of Pikermi, which proved that the plains of Marathon were haunted by antelopes, gazelles, giraffes, and hipparions, in the upper miocene age, while the forests then overshadowing rocky Attica sheltered the mastodon and rhinoceros, and yielded food to innumerable monkeys (Mesopithecus) allied to the Barbary ape. During the last five years he has been painting a like picture of the upper miocene mammalia of Mont Léberon, in which, as in Pikermi, the remains of the animals are preserved in an abundance and a perfection somewhat like those discovered in the Western States, by Prof. Marsh. The two elaborate quartos on these discoveries are now followed by an elegant octavo full of woodcuts, treating of the links that bind together some of the more important groups of tertiary and living mammalia. In it the author deals with the European mammalia without treating exhaustively the accumulation of facts brought to light by Marsh, Hayden, Leidy, and others, in the American eocenes and miocenes. Nor are these as yet published in sufficient detail to allow of their being worked into the book before us. The impression made upon my mind by the vast stores of remains in the museum at Yale is one of profound melancholy; for so numerous and varied are the mammalia that many years must elapse before they can be brought into complete relation with those of Europe. Up to the present time the fragmentary notices which have appeared bear the same relation to the systematic treatment to be expected from Prof. Marsh, that isolated *tesseræ* bear to the whole design of a mosaic. Prof. Gaudry, therefore, has acted well in confining his work mainly to the Tertiary mammalia of Europe.

Our author approaches his subject from the point of view offered by evolution, by taking some of the more salient characters of a group, and tracing their "descent with modification," in passing from older to newer stages of the geological record. The fishes passed through the principal phases of their evolution in the Primary, the reptiles manifested their most extraordinary modifications in the Secondary age, and at its close had settled down into that equilibrium which they now present, while the mammalia were being unfolded, form after form—"en pleine évolution"—in the Tertiary Period. In the opening chapter the relation of the marsupials to the placental mammals is discussed, and our author concludes, from the results of embryology, that the former must have preceded the latter, and that the imperfect and helpless condition of the young, nourished in a marsupium, or taking refuge on the back of the mother, would be a serious obstacle to rapid increase, since the young would be likely to be drowned in the passage of rivers or arms of the sea in migration in search of food. This may have been one of the causes of their being supplanted by the placental mammals at the beginning of the Tertiary Period, as they would be heavily weighted in the struggle for life by this condition. The elimination of the marsupial herbivora from the Tertiary fauna of Europe and America might have been produced by the migration rendered necessary by the great geographical and climatal changes at the close of the cretaceous age. It is a significant fact that the only living mammalian genus found in the eocene age is the tree-haunting Didelphys, which took refuge probably in the forests, and held its place in Europe as late as the lower miocene age, and which still holds its own in the warmer parts of America as the sole representative of a Secondary marsupial fauna once in possession of the European and American continents. There are, however, traces of a marsupial fauna other than those offered by Didelphys, to be seen in certain *intermediate forms.* The Hyænodon of the eocene and lower and middle miocene, and the eocene Pterodon, were carnivores combining the dental formula of four true molars (three of which are carnassials), and three premolars of the *Thylacinus,* with the characters of an ordinary placental carnivore. The dentition of the lower eocene Palæonictis is remarkably like that of the Tasmanian Dasyure, and the lower miocene Proviverra unites a marsupial dentition and brain with the ordinary viverrine attributes. These marsupial characteristics can only be accounted for on the hypothesis that they have been handed down from a marsupial ancestry, and they render the conclusion highly probable, that all the placental are descended from the implacental carnivores.

Prof. Gaudry points out that the rhinoceros and the palæothere are probably descended from common ancestors, and shows the gradual modification of skull, and evolution of horns in the former animal. In the middle miocene a hornless rhinoceros (Aceratherium) appears, and is accompanied in the upper miocenes of Eppelsheim by a small horned species, of which it is probably the female. As we pass upwards to the pliocene the horn becomes more highly developed, and the nasal bones more strongly built, until we arrive at a maximum in the pleistocene *Rhinoceros tichorhinus.* We believe that the horn was originally a male character transferred ultimately to the female in the way pointed out by Mr. Darwin.

In like manner, also, our author traces the evolution of horns and antlers in the ruminants. The earliest representative of the order, if it be a representative, is the hornless Xiphodon of the upper eocenes. Horns come in in the middle miocene, and in the upper attain a considerable development, as in the antelopes. We may add that, in Europe, the bovine development of horns arrived at its maximum in the gigantic bisons and uri of the pleistocene, while in the pliocene of Italy there was a bos without any horns—a fact which renders it probable that the polled cattle produced by domestication is merely a case of a reversion to an ancestral type fostered by the care of man. None of the lower miocene deer possessed antlers. In the middle miocene they are bifurcated, as in the Muntjac; in the upper they are still small, and with three or more types; in the pliocene they pass through the stages presented by the

Axis and Rusa, ultimately culminating in the wonderfully complex antlers of *Cervus Sedgwickii* of the forest bed, and *C. dicranios* of the Val d'Arno, and in the gigantic antlers of the pleistocene, and pre-historic Irish elk. It must, however, be pointed out that the *Cervus Matheronis* of the upper miocene, identified by Prof. Gaudry with the Axis, has no relation with that animal, as may be seen by the examination of the most perfect antlers yet discovered of the former animal, in the British Museum. A more rudimentary form of antler (*Procervulus*, Gaudry) even than the Muntjac has been discovered in the middle miocene strata of Thenay, without a burr, which was, like ordinary horns, persistent through the life of the animal.

We have merely touched upon some of the questions raised in this work, which occupies most important ground in the evolution controversy, and may be looked upon as one of the first fruits of the principles laid down by Mr. Darwin in the "Origin of Species."

W. BOYD DAWKINS

AMERICAN GEOLOGICAL SURVEYS

United States Geological Exploration of the Fortieth Parallel. By Clarence King, Geologist in Charge. Vol. II. *Descriptive Geology*, 1877. Vol. IV. *Ornithology and Palæontology*, 1877. (Washington: Government Printing Office, 1877.)

THE important survey of a portion of the north-western states of America, which was commenced by Clarence King and his able assistants in 1867, has now, after ten years of arduous labour, been brought to a close. In the original scheme drawn up for the publication of the results of this survey it was proposed that the observations of the surveyors should be published in five volumes, devoted to the following subjects:—

I. Systematic Geology.
II. Descriptive Geology
III. Mining Industry.
IV. Zoology and Palæontology.
V. Botany.

The third of these volumes was prepared and issued soon after the commencement of the survey. It abounds with valuable details concerning the rich ore deposits of the north-west and the methods by which they can best be worked. It is difficult to know which to admire most—the accuracy and beauty of illustration of this volume or the characteristic energy and promptitude with which it was produced in order to meet a pressing want.

In 1876 a supplementary volume numbered VI., not contemplated in the original scheme, was published; it deals with the subject of Microscopic Petrography, and is from the pen of Prof. Zirkel, of Leipzig. As this work has already been noticed in the pages of NATURE, we need do no more on the present occasion than refer to the circumstances under which it was published.

Two other volumes, those numbered II. and IV. are now before us, and amply sustain the high reputation which Mr. Clarence King and his indefatigable fellow-workers have acquired for energy and zeal in the prosecution of their important task, no less than for great geological knowledge and literary ability.

The volume on Descriptive Geology consists of a series of chapters giving full and accurate accounts of the geological features of the Rocky Mountains, the Green River Basin, the Utah Basin, the Nevada Plateau, and the Nevada Basin respectively, the descriptions being from the pens of Arnold Hague and S. F. Emmons. The rocks exposed in this vast area include representatives of the whole series of geological formations from the Archæan to the Post-pliocene, together with many plutonic and volcanic masses belonging to various geological periods. The descriptions are of the most minute and careful character, and are interspersed with valuable analyses of the rocks described.

One of the most useful features of this volume is the series of twenty-six lithographic plates illustrating the grand and peculiar scenery of the district. These are admirable copies of photographs taken upon the spot, and they are probably, without exception, the most successful attempts to illustrate scenery in this manner that have ever been made. We would especially instance Plates V. and VI., illustrating the Tertiary bluffs near Green River City, Wyoming, and Plate XIV., showing the characters of the Wahsatch Limestone Cliffs, Provo Cañon, Wahsatch Range, as presenting the characteristic features of rock-masses in a manner which cannot fail to be appreciated by every geologist who has had opportunities for extensive observation in the field. Other plates, such as X., representing the Agassiz Ampitheatre in the Uinta Mountains, and XIX., in which a ridge of Archæan quartzite in the Humboldt Range is depicted, are wonderfully striking reproductions of the remarkable scenery of the district. In a series of plates illustrating the saline springs, we have the peculiar features of the great plains also presented to us in a very vivid manner.

Volume IV. consists of three parts. In the first of these a series of fossils from all the formations, from the Silurian to the Tertiary inclusive, are described by the late F. B. Meek. This part is illustrated by seventeen lithographic plates of great excellence. The second part is by James Hall and R. P. Whitfield, and describes certain new forms, from the Primordial to the Jurassic; it is illustrated by seven plates.

The third part of the volume is devoted to the description of the habits of the various species of birds met with during the several expeditions. It is from the pen of Mr. Robert Ridgway, the zoologist attached to the staff.

The United States Government is to be congratulated on having been able to secure such valuable illustrations of the natural history of their extensive and interesting territories as are contained in the splendid volumes before us, and the value of these contributions to science is greatly enhanced by the liberality with which they have been distributed among scientific workers and public libraries in every part of Europe. We shall look forward with much interest for the appearance of the other volumes of the series.

J. W. JUDD

OUR BOOK SHELF

Tent Work in Palestine. A Record of Discovery and Adventure. By Claude Regnier Conder, R.E., Officer in Command of the Survey Expedition. Two vols. (London: Bentley and Son, 1878.)

THIS is the first substantial result of the survey of Palestine, which has been going on for the last few years. It is published by the Committee of the Palestine Exploration Fund, but is merely preliminary to the publication of the various detailed memoirs and the unprecedentedly minute map which are in preparation. It is mainly the narrative of Lieut. Conder's personal work and adventure, but besides its strong interest as a record of adventure in one of the most interesting countries in the world, it contains a vast amount of information and discussion concerning the many places so full of sacred associations to all Christian peoples. The work of the Survey was often pursued under considerable hardships, and occasionally at some risk, and more than one of the staff had to succumb during the progress of the work. It is evident that this most interesting of surveys has been executed with a minuteness and a care that leave little to be desired. The survey was actually commenced at the end of the year 1871. Capt. Stewart, the first officer in charge, had to come home on account of his health, and in July, 1872, Lieut. Conder took up the command, and completed four-fifths of the survey, the remaining fifth being carried out in 1877 by Lieut. Kitchener. The great map now extends over 6,000 square miles, from Dan to Beersheba, and from the Jordan to the Mediterranean Sea. This map is being prepared in twenty-six sheets; and an idea of its minuteness may be obtained from the fact that it will show tombs, caves, cisterns, wells, springs, rock-cut wine-presses, remarkable trees, and even the Roman milestones. Accompanying the map will be a memoir prepared by Lieut. Conder under the direction of Major Wilson and Mr. George Grove. It is hoped that all will be ready for publication in the course of a few months. This memoir will contain a vast collection of varied information gathered from many sources, and with the map will undoubtedly be of infinite service to students of the Biblical narratives. Lieut. Conder's work will amply repay careful study, and the many illustrations of places whose names are "familiar as household words," add greatly to its interest and value.

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.*]

Discovery of Vulcan

A LETTER from the Astronomer-Royal, in NATURE, vol. xviii. p. 380, giving the exact position of θ Cancri on the day of the total solar eclipse, intimates that, as the position given by Prof. Watson of the intra-Mercurial planet discovered on that day agrees so closely with that star, it may have been the object discovered, I have thought it advisable to give the facts concerning it, in order to correct such an impression if it still exists. That he had a view of the planet as stated there is no doubt, for I myself saw it some four or five minutes later, using θ as a comparison star, and am able not only to corroborate the discovery, but to substantiate the position given by him. Its proximity to θ enabled me to estimate its position with great exactness, especially in declination. It may be well here to state that I was prevented from searching to the east of the sun, in consequence of forgetting to untie a string with which I had tied, to the eye end of the telescope, a long pole to prevent the wind from shaking it, the end resting on the ground not allowing the instrument to be moved to the eastward. It is undoubtedly to this circumstance, which at the time seemed untoward, that I owe the discovery of Vulcan. In my eagerness to discover this hypothetical planet I had decided to ignore nearly all of the phenomena attending the eclipse, and as, at the commencement of total phase, there was visible neither the chromosphere nor any protuberances—nothing, in fact, but the corona, I almost immediately began the sweeps for it; but my hampered telescope behaved badly, and no regularity in the sweeps could be maintained. Almost at once my eye caught two red stars about 3° south-west of the sun, with large, round, and equally bright discs, which I estimated as of the fifth magnitude, appearing (this was my thought at the time) about as bright in the telescope as the pole star does to the naked eye. I then carefully noted their distances from the sun and from each other, and the direction in which they pointed, &c., and recorded them in my memory, where, to my mind's eye, they are still distinctly visible. I then swept southward, not daring to venture far to the west for fear I should be unable to get back again, and soon came upon two stars resembling in every particular the former two I had found, and, sighting along the outside of the tube, was surprised to find I was viewing the same objects. Again I observed them with the utmost care, and then recommenced my sweeps in another direction, but I soon had them again, and for the third time in the field. This was also the last, as a small cloud hindered a final leave-taking just before the end of totality, as I had intended. I saw no other stars besides these two, not even δ, so close to the eastern limb of the sun. The distance between them was about 7′ or 8′.

By three careful estimates the two stars pointed exactly to the sun's centre. When it is considered that a deviation of not over 15″, in two objects so close, will cause them to point considerably to one side of the centre of the sun—three degrees away—it may be assumed that its declination was quite correctly estimated. Thus far all seems clear and free from doubt, but it is just here where the trouble begins, for, unfortunately, I could not tell which was the star and which the planet. Happily Prof. Watson comes to the rescue, and with his means of measuring, says "the planet was nearest the sun."

The Astronomer-Royal gives the place of θ, on that day, as in R.A. 8h. 24m. 40s., Decl. + 18° 30′ 20″. From this I deduce the position of the planet at 5h. 22m. Washington M.T. to have been in

R.A. 8h. 26m. 40s.
Decl. + 18° 30′ 25″.

This is a close approximation to that given by Prof. Watson. It is to be hoped that a comparison will determine the position in its orbit, whether it was approaching superior conjunction, as Watson thinks, or, as appears most reasonable to me, had just passed its inferior conjunction.

LEWIS SWIFT

Rochester, N. Y. September 4

The Respiration of Plants

I DESIRE, with your permission, to give publicity in the columns of NATURE to the results of some observations on the above subject, communicated by me to the Royal Society of Victoria on June 13. As the facts to be mentioned are not referred to in Sachs' "Text-book of Botany," in the dictionaries of chemistry of Watts and Wurtz, or in recent volumes of the *Journal of the Chemical Society* or the *Chemisches Centralblatt*, I presume that they are little, if at all, known to botanists. I have found, first about nine years ago, and have more systematically observed lately, that fresh sections of many fruits, such as the apple and pear, and other vegetable structures as the potato, turnip, &c., give the reactions considered to be characteristic of ozone, viz., causing separation of iodine from iodide of potassium, and turning tincture of guaiacum blue, the intensity of these reactions varying in different samples of the vegetable substances, but depending mainly on their comparative freshness. I have further found that the same structures contain a substance which acts as an *Ozonträger*, to use Schönbein's expression, a substance which transfers ozone from peroxide of hydrogen and similar articles. This is shown by the fact that if the guaiacum is not blued at all, or only to a slight extent, the blue colour becomes very marked when a drop of ethereal solution of peroxide of hydrogen is added. I infer from these observations (1) that the oxygen inhaled by living plants, and even by pulled fruits for a time, is ozonised or rendered active, probably by entering into loose combination, as is the case with the oxygen in the blood of animals; and (2) that it is probable, though not proved, that the ozone-transferring substance existing in almost every fresh vegetable structure is that with which it is loosely combined, as the oxygen in the blood is with the hæmoglobin of the red corpuscles, which is a very active *Ozonträger*. This element in plants is gradually destroyed as decay comes on, and ceases to perform its ozone transferring function when the fruit, &c., containing it is cooked. It is not chlorophyll, as is shown by its situation, and it seems to be intimately associated with the vascular tissue. From analogy with the animal substances hæmoglobin, fibrin, myosin, &c., which have a similar action, it may be presumed to be proteinaceous, though I am unable to indicate its chemical and other characters more exactly. The interesting analogy between the respiratory functions of animals and plants indicated by these observations will, I hope, be considered a sufficient excuse if I ask you to insert this short summary of my paper which you will receive at the same time. JAMES JAMIESON

Melbourne, July 6

The Electro-Magnet a Receiving Telephone

THE experiment of Mr. F. G. Lloyd, described in NATURE, vol. xviii. p. 488, is simply a repetition of Page's original experiment, the basis of all telephony. The electro-magnets of ordinary relays and Morse apparatus make capital telephone receivers when their armatures are screwed up, and it is a common thing for operators at intermediate stations in America to enjoy the music that is being transmitted between the terminal stations during some telephonic display. I remember the station-master at Menlo Park telling me that the music sent from New York and received at Philadelphia was heard, much to his surprise and delight, all over his little wayside station. The effect is dependent upon the strength of the currents flowing. With a Riess' transmitter sending musical notes and voltaic currents it can be made very loud. With an Edison or a Hughes transmitter the effect is much less, and with a Bell transmitter it is almost, if not quite, inaudible.

Electro-magnets also can be used as transmitters, because their iron cores invariably contain some residual magnetism.

September 16 W. H. PREECE

Rayons de Crépuscule

IN your issue of July 25, Mr. Abbay, in writing of Ceylon, says that, as far as he is aware, the *rayons de crépuscule* are never seen in the low country.

Allow me to add the weight of my testimony to that of Mr. Pringle, given in NATURE of August 1.

During a residence of about five weeks here, the rays have been noticed from twelve to fifteen times, and I have been told by an old resident that their appearance is very common.

This country is the perfectly flat alluvial land and marsh bordering the Gulf of Mexico, whose shores are distant about eight miles from our camp.

On fully half of the occasions have the bands been traced from the sun, without break, to the point in the east, 180° from it. The rays are seen best when the sun is very near or below the horizon. On the evening of August 16, the display was exceptionally beautiful. The sun had set behind a bank of dense cumulus clouds, while the remainder of the heavens was covered with very faint cirro-cumulus clouds. A band of dark blue spread from the sun, and after widening to about 85° near the zenith, converged to a point either in, or slightly below the horizon. This was the cloud's shadow. In the south a line about 15° wide, and in the north, one about 80° wide, were lighted up, and shone with brilliant tints, varying from rose to orange. The lines between the deep blue of the shadow, and the lighter blue, mottled with the shining, closely packed cloud flecks, were sharply marked, as sharply, indeed, as the arch in the Aurora, which it called to mind. I have noticed the phenomenon several times in Maryland, in a gently rolling country, but nowhere have I seen it as often and as distinctly as here.

JULIUS KRUTTSCHNITT

Morgan's La. and Texas R. R. Camp, St. Mary Parish, Louisiana, August 24

"LES rayons de crépuscule" seem not to be of uncommon occurrence. They presented a most superb spectacle at this place last Sunday evening. The weather had been extremely warm all day and the mountains were seen through a thick haze. At sunset masses of dark clouds, fringed with gold, lay along the horizon to the west, while beyond them the sky was of a beautiful pink. As the sun sank lower many bands of pink appeared, stretching from the west entirely across to the east, appearing broader and paler, of course, near the zenith. They changed gradually in width, position, and number for perhaps half-an-hour, and then disappeared. Their changeableness indicated that they were due to clouds near the horizon.

Sing Sing-on-the-Hudson, September 3 H. S. CARHART

The Microphone

THE form of microphone described by Mr. Gerald B. Francis (NATURE, vol. xviii. p. 383) is easily made and very efficient. It not only did for me all its inventor promised, but with a common tumbler inverted over it upon the sounding-board so as to prevent direct impact of sound waves upon the ball, it became a powerful transmitter of the human voice. I conversed easily and satisfactorily with a friend a half-mile from my end of the wire. The exact contact of the lower wire with the ball was effected by a screw with a very fine thread passing through without touching the lower block or cup. The voice must be kept low to prevent bounding of the ball so as to break contact. Bell telephones were used as receiving instruments, the batteries being Hill and Calland gravity batteries used extensively in this country upon telegraph lines. These batteries agree exactly in every respect with the one used by Prof. Hughes in his interesting experiments excepting the clay, which is not necessary, and must be a great inconvenience in a permanent arrangement. S. T. BARRETT

Port Jervis, New York, August 30

A White Swallow.—Albinism in Birds

BY the side of a steep sand-cliff overhanging a stream—the Cambeck, in Cumberland—I lately saw, on a glorious summer afternoon, a white swallow flying about with many other birds of the same species. A most beautiful bird it was; perfectly snow white, with perhaps a slight tinge of blueish grey near the roots of the tail-feathers. In size it seemed to be rather smaller than the swallows around it; but in its flight and pursuit of insects there was no noticeable difference. From my position at the top of the cliff I could often see the bird within a very few yards of me.

Like the grouse of which Sir Joseph Fayrer writes in NATURE (vol. xviii. p. 518), this white swallow is, I believe, of considerable rarity. I have been able to hear of only one, seen many years ago near Repton, in Derbyshire; and in numerous works on British and other birds which I have consulted, I cannot find any very precise mention of a white variety. Magillivray remarks of the *Hirundo riparia*, the species to which the bird I saw belonged, that "individuals of a whitish colour are said to occur, but I have never met with any remarkable deviations from the ordinary appearance." Yarrel speaks of a white variety of the common swallow as not uncommon; while of the same swallow, or *Hirundo domestica*, several varieties are recorded by Buffon, and among them the white, there being "no country in Europe where these have not been seen, from the Archipelago to Prussia."

Able to catch flies on a cloudless summer day, this white swallow can, I hardly think, have been an albino, although I had no opportunity of such close inspection as Sir Joseph Fayrer had of the grouse he shot near Dunrobin. Albinism in birds must, I should imagine, be altogether unknown or unobserved, for I can nowhere meet with any account of it. Undoubted albinos are sometimes spoken of as "white varieties"—an albino monkey is, or lately was, so labelled at the Zoological Gardens; and it is possible that this very general term may include some cases of albinism, even among birds.

HERBERT W. PAGE

New Cavendish Street, W., September 16

The Hearing of Insects

I AM not aware if it is generally known that there is a wasp in South America which seems to present undoubted evidence of a faculty to hear, or it may be to feel, and distinguish certain vibrations of sound.

The wasp is a common one on the Guayaquil River; a large slender black species, much feared on account of the virulence of his sting, which not unfrequently produces fever. I, myself, though little susceptible to the bites of mosquitoes or flies, and the stings of scorpions, &c., when once stung on the finger by a "cubo," as this wasp is called in Ecuador, had my whole hand and forearm considerably swollen for a couple of days.

A common spot chosen by the cubo for his nest is high up on a palm stem at the river-side, and natives are well aware of the danger of uttering any loud cry when in its proximity. I have frequently experimented by giving a shrill whistle—his particular abhorrence—from a safe distance, with the invariable result of all the wasps flying in confusion from the nest in manifest anger.

It is said that there is a wasp in New Granada in whose proximity one dare not speak, but for this I cannot vouch, and very possibly this may be an exaggerated account of the cubo. It would certainly be a dangerous experiment to speak loud when very close to a cubo's nest, even on the Guayas, and a shrill voice would be sure to irritate the wasp. ALFRED SIMSON

4, Fairlie Place, Calcutta, August 20

Circulating Decimals

IN NATURE, vol. xviii. p. 291, is an extract from a letter by Mr. R. Chartres, in which is given a remarkable property of certain circulating decimals. Mr. Chartres only refers to fractions of the form $\frac{1}{nr-1}$ (where $r = 10$); but I have since found that a somewhat similar property belongs to other fractions when expressed as circulating decimals.

For instance, $\frac{1}{7} = \dot{1}4285\dot{7}$; here we observe that the last figure of the circulator is the same as the denominator of the vulgar fraction; moreover, by multiplying the 7 by 5, we get the next figure, and this by 5, taking in the remainder, gives the third from the end, and so on till we get the whole recurring decimal.

So far this is somewhat similar to Mr. Chartres' discovery, but now observe the curious property in the following fractions:—

$$\frac{1}{7} = \cdot\dot{1}4285\dot{7}$$
$$\frac{1}{17} = \cdot\dot{0}58823529411764\dot{7}$$
$$\frac{1}{27} = \cdot\dot{0}3\dot{7}$$
$$\frac{1}{37} = \cdot\dot{0}2\dot{7}$$

In each case the last figure of the circulator is the same as the unit figure of the denominator of the vulgar fraction. Now the multipliers which give the remaining figures are, for the first fraction, 5; for the second, $(5 + 7)$; for the third, $(5 + 14)$; for the fourth, $(5 + 21)$; and generally to convert a vulgar fraction of the form $\frac{1}{nr+7}$ $(r = 10)$ to a circulator, we put down the last figure 7 and multiply successively by $7n + 5$.

For fractions of the form $\frac{1}{nr+3}$ the multiplier is $3n + 1$, and the last figure 3.

For fractions of the form $\frac{1}{nr+1}$ the last figure in the circulator is 9, and the multiplier is $9n + 1$.

Of course the last figure must be that one which, multiplied into the unit of the denominator, and the unit of the result being subtracted from 10, leaves a remainder of 1.

These rules added to that of Mr. Chartres include every case of fractions which, when reduced to decimals, circulate.

Littlehampton, Sussex EDMUND P. TOY

Autophyllogeny

WITH reference to the note in NATURE on autophyllogeny in a leaf of *Papaya vulgaris*, I wish to place on record another freak which I have more than once noticed in the Papeea or Papeeta, as we call *Carica papaya* out here. The plant is diœcious, the female being stumpy and her flowers and fruit sessile; the male plant, on the other hand, is tall and graceful, and the flowers depend from long stalks. The freak I have above alluded to *consists in the presence of distinct and well-formed fruit on the male plant*, and I regret I was unable, on both occasions, to secure the anomalous production for examination. R. F. HUTCHINSON, M.D.,

Mussooree, August 19 Surgeon-Major, Bengal Army

The Sea-Serpent Explained

THE letters of Dr. Drew and others remind me of what I witnessed at Sandgate twenty-four years ago. I was staying at a cottage on an elevation which commanded an extensive sea-view. One morning my attention was called to a large, dark, undulating body, which moved rapidly through the sea. As it was some way out from shore, I naturally concluded it to be of enormous length. I lost no time in making inquiries as to the nature of this phenomenon, and was so fortunate as to discover a fisherman who had witnessed it. He told me it was a flight of petrels. But for this I should certainly have believed that I had seen the Great Unknown. I have often seen a similar phenomenon, but nothing nearly so striking as this.

Valentines, Ilford, September 16 C. M. INGLEBY

RECENT PROGRESS OF SELENOGRAPHY

THE most active period in the study of selenography during late years is comprised between two epochs, that of the announcement of a change in the crater *Linné* in the year 1866 by Dr. Schmidt, Director of the Observatory at Athens, and that of the announcement of a new crater north-west of Hyginus, by Dr. Klein, of Cologne, in the year 1877. The years elapsed between the two events above-mentioned have been characterised more or less by the manifestation of considerable interest in lunar studies, of which the projection of a map of the moon 200 inches in diameter, to have been constructed under the auspices of the British Association for the Advancement of Science was the first indication. Of this map, four sections embracing an area of 100 square degrees of lunar latitude and longitude have been published, containing all the formations known in 1866-1868 to exist on this area, each of which is separately catalogued. Three of these sections, with catalogues, were published in the *Reports of the British Association* for 1866 and 1868; the fourth was published by the aid of a private subscription, in 1870. We are not aware that much use has been made of these areas and catalogues in endeavouring to ascertain if the 433 objects chronicled in them retain the characteristics they possessed in the above-mentioned years. It was a part of the duty of the Committee appointed by the Association to receive the reports of volunteer observers who undertook to examine the objects in certain subzones at stated intervals, which resulted in the addition of several new objects to those originally published, but nothing has been effected in this direction since the Committee was not reappointed in 1868.

In February, 1869, a map of the Grey Plain, the *Mare Serenitatis*, was published in the *Astronomical Register* for that month, by Messrs. Joynson and Williams. It contained several new objects not on former maps, and was followed in the course of a few months by a map and monogram of the same region. The map was divided into the British Association areas, and it contained 277 objects, each being distinguished by a British Association symbol; they were briefly described in a table of the areas in which any part of the Mare was found.

The four areas of the British Association map on a scale of 200 inches to the moon's diameter accompanied by a monogram of the formation *Hipparchus* on a scale of 100 inches, with that of the *Mare Serenitatis* form a collection of maps, which, with the descriptions of 710 separate objects embody the conditions of those portions of the moon's surface which were telescopically or photographically examined between 1866 and 1870. As placing in the hands of the student a body of facts especially suitable for future reference, these maps and monograms will furnish most important information on the condition of objects recorded on or in them during the four years above mentioned. It is in the future the real progress of the past is more truly measured.

In the years 1871 and 1872, Reports of a Committee appointed for discussing observations of lunar objects suspected of change, was read before the British Association for the Advancement of Science, the principal results being the discovery of about thirty-six spots and crater cones upon the floor of the walled plain *Plato*, which were very variable in visibility; also of several streaks which were not only variable in visibility but also in form; the most usual shape that was observed was that of a trident on the south-west part of the floor. There appeared to be a close connection between the spots and streaks, but its nature was not mentioned in the reports further than a surmise that the appearance of certain streaks appeared to be coincident with an increased visibility of certain spots. Another result was a brightening of the north-west floor, for a time only, as well as a brightening of several of the streaks, but perhaps the most important was that of a *darkening* of the darker parts of the floor as the sun rose higher above its horizon. This result has been most strenuously controverted by a popular writer, who alleges that the effect observed was due only to contrast. Be this as it may, the Report for 1872 is explicit as to a gradual darkening with increased solar altitude; at any rate the same writer bears testimony to the exceptional care with which the floor was scrutinised.

In the year 1876 (May) Neison's "Moon and the Condition and Configuration of its Surface," appeared. It marked an era in selenographical research, the English student having within his reach, for the first time, a description of the principal formations on the moon's surface in his own language. This work, of 576 pages, includes a map drawn in twenty-two sections, the principal formations on each being fully described in the body of the work. Besides the purely topographical part, the author has given five introductory chapters in which he has treated of the physical condition of the surface, the general characteristics of the lunar formations and the variations that have from time to time been detected on the surface. He has also given a most lucid chapter on the history both of the progress of mathematical investigation and selenographical research as regards the moon.

The most important recent event in the progress of selenography was the discovery, on May 19, 1877, by Dr. Klein, of a dark spot which he described as "a great black crater full of shadow without a wall north-west of Hyginus," (NATURE, vol. xviii. p. 197). It was first announced by him in his *Wochenschrift für Astronomie* for March, 27, 1878, and has since been seen by several observers who have generally confirmed the appearances mentioned by him, and also agree in their testimony that no such spot existed formerly in the region in which it was seen. In the celebrated case of Linné the information in 1866-67, as regards the *former* condition of the surface of the moon was so imperfect that it was considered by astronomers that "no change in Linné could have taken place, but that Lohrmann, Beer and Mädler, and Schmidt must have been mistaken." [1] A considerable controversy on this subject occurred during 1867-68, but nearly six months have elapsed since Dr. Klein's announcement, and we have not heard of his discovery having been seriously questioned. It is true that a certain white spot, alleged to have been found on photograms taken within the last fourteen years, has been regarded as indicative of the existence of Klein's crater during those years, and from the probability of its locality being that of Klein's crater, the conclusion has been drawn that the latter is not new. Admitting that a somewhat similar spot existed thirteen years ago, the real nature of which we are unacquainted with, and which may have disappeared in the interim, we are quite as much in the dark as to the real nature of the change ascertained to have taken place by Klein, as to the former existence of the spot discovered by him; both await further elucidation.

The recent publication of Schmidt's large map of the moon in twenty-five sections indicates the latest era of progress. If selenographers apply themselves energetically to examine it, the study of the moon's surface will make great progress; but for this purpose much self-denying labour is indispensable, as the map contains as many as 32,856 craters, exceeding those recorded by Mädler by 25,121. It is important for the true progress of selenography that all of these newly-recorded craters should be observed in such a manner as to leave no doubt of their existence. To effect this each observer should keep his record of observations in the form of a catalogue. In the earlier part of this article we have alluded to the plan adopted by the British Association, viz., of cataloguing every object inserted or to be inserted on its map, and we have also alluded to those publications which contain the descriptions of 710 objects. We believe that a comparison of those publications with Schmidt's map is in progress, and that some of the objects in them are not in Schmidt's map. It is, therefore, certain that, indefatigable as Schmidt has been, if we regard his map as perfect we shall make a great mistake. May we rather endeavour to add to the already large number of objects which he has chronicled.

[1] Neison. "The Moon, and the Condition and Configuration of its Surface," p. 125.

HYDRO-INCUBATION [1]

We wish that Mr. Christy had used a less barbarous term for his useful apparatus: that, however, is of little consequence to practical men.

At a time when our native farm-yard and dairy produce only supplies about two-thirds of what London and our secondary and third-rate towns need, anything that will assist the unready Saxon in so unsatisfactory a state of things ought to be received with gratitude.

Fowls, in a dietetic point of view, are, we are satisfied, certainly of much more importance than is ordinarily supposed. Let any thoughtful medical man in general practice think what a comfort it would be to him if well-fed young fowls were available for the poorer among his patients, and he will agree with us that such an apparatus as Mr. Christy's may become a great boon. That the masses of the people should be able, in time of illness, to purchase useful wine, the more delicate kinds of fish (such as whiting and soles), fresh eggs, and succulent and tender poultry—these are things desirable to a degree only known to those who are familiar with the treatment of diseases in the homes of the common people. Many a kindly Family Doctor passes from house to house heavy-hearted as well as (too often) overworked; the sad answer to his advice as to regimen being, again and again—"It is easy, Sir, for you to prescribe, but how can we afford these luxuries."

The old remark as to the value of an improvement in the grazing department of the farm, that should "make two blades of grass grow where only one grew before," is now more than ever pertinent. Let our readers look at the Registrar-General's returns for London only, especially in a very healthy season, such as last year, and he will see that the number of the births weekly, as compared to the deaths, is such as to add about *two thousand* hungry mouths to the population in three weeks. Then from all the provinces men and women are pouring into London and the large towns, where they need in the closer air more and better food than would have sufficed them in the country. Therefore we are glad to see energetic merchants like Mr. Christy, bestirring themselves to see what new cattle-food can be found from other climates, and how our rural people can be stimulated and helped to grow and develop for their own benefit and for the benefit of others, food of many kinds that shall be as "manna" to thousands and myriads of hungry people.

But there is another, and much more limited, sphere in which such an apparatus as the "hydro-incubator," will

[1] "Hydro-Incubation in Theory and Practice." By Thomas Christy, F.L.S. Second Edition. (London: 1878).

be of the greatest value. The readers of NATURE will appreciate anything that helps the scientific worker. Now, at last, we are going to the root of things in biology, and only the embryologist knows fully what a boon an egg-hatcher, convenient and easy to work, would be. The eggs of the hen will be wanted in their various stages of incubation, as long as there are workers in these departments, but many other sorts of oviparous animals have to be worked out in all their stages besides the common fowl. Snakes, lizards, tortoises, crocodiles, all these are rivals of the bird in their embryology, and of many kinds the eggs could be procured and their embryos developed if the worker had some such apparatus as Mr. Christy is bringing out. We want, not merely the general embryology of these ovipara, such as is so excellently illustrated and described in Messrs. Foster and Balfour's work, but the special development of any important organ ought to be traced in all its stages through not one, but many types of the vertebrata : through *all* the principal kinds indeed.

Some of us are trying to do this in the skeletal structures; the nervous system, still more important, wants an army of workers, then there are the respiratory, digestive, excretory, and generative organs, all these want a complete history in all their stages, not in one type merely, but in scores of types. We therefore wish well to all energetic and enterprising men who put it into our power to work on a wider scale; such means and appliances as can be brought out by men too restless for close and patient study, may be of infinite service to the close and patient student, who is too dreamy and abstracted to invent for himself. W. K. P.

NOTES ON SOME NATAL PLANTS

GROWING plentifully among the grass on the coast hills of Natal is a small blue flower belonging to the Rubiaceæ. In this plant, generally speaking, there are two forms only, in one of which the five stamens are exserted considerably beyond the tube of the rotate corolla, and the stigma is included in the tube; in this form the tube is almost devoid of hairs. In the other common form the position of these essential organs is reversed, the stigma protruding to about the same extent that the stamens do in the first mentioned, and the stamens being included; here, however, the upper part of the corolla tube is *thickly* covered with downy hairs—of course this is an ordinary dimorphic plant. But I find lately a third form of the same species (only, however, rarely) in which both stamens and stigma are exserted and are of the same length, so that here self-fertilisation must take place, as the stamens and stigma touch at the time the former dehisce. I do not think this can be termed a cleistogamic form, as, although rather smaller and lighter in colour than the others, the difference is only trifling. The hairs which cover the corolla-tube in the form with included stamens serve to keep the pollen collected near the upper part of the tube, as, if it fell to the base it would not be so easily transferred by the proboscis of an insect as when lightly held by the hairs through which the insect must make way. As these hairs would be for this purpose useless when the stamens are exserted they do not occur in the other form.

I notice the same arrangement of hairs in another dimorphic plant belonging, I think, to the same order, which grows on the marshy flats near the sea. I have found on the coast lands here four other plants, in which cross-fertilisation is secured by dimorphism, one of them being a monocotyledonous plant.

There is a species of *Polygonum* which climbs in the bush which well illustrates another plan ensuring cross-fertilisation; while the flower is young and the perianth still closed, enveloping the immature stamens, the three branching stigmas protrude from between the segments in a fit state to receive the pollen. If (as is usual) the ripe stigmas were only exposed when the flower opens, although the evils of self-fertilisation would of course be avoided by the plant being proterogynous, still, as it is wind-fertilised, the perianth and stamens would be in the way of any stray pollen-grains reaching the stigmas; while as it is, nothing interposes between pollen and stigmas.

Lately I have found a curious aberration of form in *Tecoma capense* growing here. It is very common in the bush, forming great beds of bright colour, and normally has a scarlet trumpet-shaped corolla, with one rudimentary and four perfect stamens. I found, however, three or four plants growing within a short distance of each other, in which there were eight perfect stamens; they seemed, however, to have been formed at the expense of the corolla, for there was only one segment coloured at all, the remainder being colourless and small. The ovary seemed in several cases to have been fertilised. The ordinary form of this plant, although individually so brightly coloured, growing in large numbers and secreting much nectar, is seldom or never visited by Lepidoptera. It is, however, frequented by honeysuckers and small bees in numbers. All through the day you can hear the shrill chirp of the small bright honeysucker among the blossoms. The immediate reason why butterflies and moths do not visit it I cannot give; but the stamens and stigma (which are beneath the large upper segment of the corolla) are long, and so high above the opening of the corolla-tube that those insects, in visiting the flower for its nectar, would not be at all certain to touch either, and so in comparison to the honeysucker and small bees would be of little benefit to the plant; for when the former of these visits the flower the feathers of his head are just of the height to brush off the pollen, and the latter in collecting the pollen is equally certain to distribute it, as the bifid stigma is about the same length or only slightly longer than the stamens. Can the nectar have been modified to suit the taste of the useful honeysucker without reference to the useless butterfly?

Natal, June 27 M. S. EVANS

PHYSICS IN PHOTOGRAPHY [1]

III.

THESE last experiments were remarkable in another point of view, as they opened out the question as to whether the salts of silver might not prove sensitive to rays to which they had been supposed hitherto to be insensitive. Silver iodide, for instance, when exposed to the spectrum in a solution of potassium sulphite proved sensitive as far as "*a*" of the spectrum instead of stopping short at the point indicated in Fig. 2 (p. 529); and silver bromide in the molecular grouping which absorbed the red proved sensitive to a wave-length of somewhere near 11,000, whereas in its normal state 9,600 was its limit.

Similarly silver chloride proved sensitive to an extent which presumably may be increased till it is equal to that of the bromide. In both these instances we have a proof that the compound was sensitive to these abnormal rays, and that the image formed by those rays was destroyed as soon as formed by their oxidising action giving an undevelopable form of salt. It may be remarked that by exposing films in reducing solutions such as ferrous sulphate, and pyrogallic acid rendered very slightly alkaline, that an image can be developed as fast as it is formed.

The natural outcome of the experiments on the oxidation of the photographic image just narrated is that it should lead to the solution of the problem of photography in natural colours, such as that of Becquerel, Niepce de St. Victor, and others. In the fourth edition

[1] Continued from p. 531.

of Hunt's "Handbook of Photography," we read, at p. 161, "Niepce de St. Victor has made many experiments to produce the colours upon salts of silver and copper spread upon paper, but without success; the metallic plate appears absolutely necessary, and the purer the silver the more perfect and intense is the impression." The following is recommended as the most effectual mode of manipulating:—"The plate is highly polished with tripoli powder and ammonia; being perfectly cleaned, it is connected with the battery and plunged into the bath prepared in any of the ways stated. [The baths were made from ferric chloride, cupric chloride, hydrochloric acid, &c.] It is allowed to remain in the bath for some minutes, taken from it, washed in a large quantity of water, and dried over a spirit-lamp. The surface thus produced is of a dull neutral tint, often almost black; the sensibility of the plate appears to be increased *by the action of heat*, and, when brought by the spirit lamp to the cerise red, it is in its most sensitive state."

"The sensibility, however, of the plates is low—*two or three hours* being required to produce a decided effect in the camera obscura. . . . These, when I first saw them, were perfectly coloured in correspondence with the drawings of which they were copies, but the colours soon faded, and it does not appear as yet that any successful mode of fixing the colours has been discovered." The coloured spectra which Becquerel photographed were produced in a somewhat similar way, the variation from which need scarcely be repeated.

In Hunt's work we also find that natural colouration of photographs was found to be possible by one or two other processes, but that the above gave the most satisfactory results. Mr. Simpson also noticed when using an emulsion of silver chloride and after exposing the film to white light so as to tint the surface with a lavender colour, that he was able to reproduce on the film the tint of different coloured glasses to which such a surface might be exposed.

It will be noticed that the coloured spectra were produced on a dark compound of silver which gradually responded the colour falling on it. We have first a case of total or nearly total absorption of all the rays, and a subsequent production of compounds of varying tints. In order to produce any variations of colour it is only necessary that we should have at the most three molecular groupings, one of which should absorb the blue and green, another the green and red, and the last the red and blue. Whether the number of groupings may be reduced to two is a question for future consideration. In Lockyer's note read before the Royal Society on June 11, 1874, "On the Evidence of Variation in Molecular Structure," we find statements which might have been conceived to be almost too bold at the time when they were made, but which subsequent investigations seem to prove to be exact. In this note he refers to definite molecular groupings of compounds and the absorption caused by them, and indicates that we may have a group which will absorb at the blue end and another which will absorb the red end of the visible spectrum. It has already been shown that the silver bromide can be reduced to two groupings, one absorbing the blue and the other the red, and it is somewhat remarkable that, by applying pressure to the latter molecular grouping, it is gradually resolved into the former grouping, and passes through all tints of spectrum between the blue and the red. It must be remembered that these colours are not the colours of thin plates, but are totally independent of the thickness of the film so long as light can penetrate through it. It is not too much to assume that if silver bromide can be made to group itself into these two states, that the subbromide when oxidized should also assume a similar molecular condition. With this compound in a state which practically absorbs all rays, it is easy to imagine that particular sets of vibrations may cause it to resolve itself into groupings which answer to them. We have, in fact, the inverse of the reduction of the silver bromide by different portions of the spectrum. It is found that one molecular grouping can be reduced by a whole series of vibrations; thus the blue absorbing molecular group is altered by all the radiations from the ultra violet to the yellow, and the red absorbing molecular group by the radiations from the ultra-red to the green. If there were a green absorbing molecular group, of which there is a strong suspicion of the existence, it would probably be altered by radiations from the blue to the orange. If, then, one silver compound can exist in two or three states of molecular grouping, it is quite within the range of reason that the oxidised compound should exist in the same three groupings. The black compound to which we have already referred, in fact, does arrange itself thus, probably by a re-arrangement of molecules, as formed when it absorbs oxygen. If a plate be prepared in a similar manner to that described above, and if it be exposed in an oxidising medium, these groupings are attained rapidly, a few minutes sufficing where previously hours were required. The images thus formed, however, appear not to be unchangeable, as exposure to white light, or to any colour except that in which the re-arrangement takes place causes the colours to fade. The feat of producing *permanent* photographs in natural colours is as yet unsolved, but it may not be so far distant as may be imagined. In order to obtain them it is necessary that a method should be found by which the molecular groupings of metallic silver can be formed in either of the two (or three) states already described. As is well known, the absorption by metallic silver in a thin film takes place entirely in the red end of the spectrum, but it is a fact well known to photographers at large, that in certain processes it is perfectly feasible to obtain silver in which the transmitted light is of a pink red colour, whilst tints varying from indigo, passing through olive green to rich brown are familiar. In order to obtain permanent photographs in natural colours, the object to be sought is a method by which the sensitive silver compound may be reduced by the red rays to a molecular grouping, which on development (probably by the alkaline method) shall be grouped into the red transmitting molecular grouping, and so on. When this is discovered, the leap between monochromatic pictures, and chromatic, will have been taken, and the once apparent improbability have become more than a possibility.

We have finally to return to the subject of photography with the light of those rays which are usually inactive upon sensitive salts, and at which we have already glanced.

To Dr. H. Vogel, of Berlin, is undoubtedly due the new interest which has been taken in this branch of photography. Towards the end of the year 1873 he announced that he had discovered a method of making the non-actinic rays in certain circumstances actinic. We quote his own words[1]:—"I have found that bodies which absorb the yellow ray of the spectrum make bromide of silver sensitive to the yellow ray. In like manner I find bodies which absorb the red ray of the spectrum make bromide of silver sensitive to the red rays. For example, by the addition of *corallin*—which absorbs the yellow ray—to a bromide of silver film, it becomes as sensitive to the yellow ray as to the blue ray." In articles which he published at various times he enlarged on this idea, some of his most striking experiments being conducted with aniline dyes of various kinds. He and Waterhouse have shown that a silver bromide film becomes sensitive to the part of the spectrum which certain of those dyes absorb, whether the absorption be due to a compound formed between the dye and silver, or to aqueous or alcoholic solutions. This at once opened

[1] *Photographic News*, December 5, 1873.

out a large field for inquiry, and made research in this direction doubly interesting owing to the fact that apparently certain physical laws would have to be modified if Vogel's theory were correct. He divided the action of the substances so added into two, the dye he called an optical sensitiser for that particular part of the spectrum which it absorbed, whilst bodies which absorbed the halogen (thrown off by the reduction of the molecule) he called a chemical sensitiser, and a combination of both properties in a dye made the film sensitive to the absorbed rays. The theory of the optical sensitiser seemed to clash with the received notion of molecular motion, but before analysing the results the accompanying figure should be studied, which is taken from Vogel's work on Photography (Fig. 5).

Let us take one or two examples from the above figures and see whether they agree with Vogel's assumption. We will take VIII. as a standard of comparison, being the effect on unstained bromide, and this will be fair (though it does not take the form given, shown in Fig. 2, p. 529), as it is presumed that this sample of bromide was worked with throughout. Comparing say IV. with VIII. we see that in the blue the sensitivenesses, as shown by the ordinate of the curved line, are very similar, but that the action is got in the yellow. In examining cyanine blue, the dye used, we find that the absorption takes place just at that part of the spectrum. Similarly examining V. and VI. we arrive at the same results, and in fact the absorption of the rays invariably corresponds with the photographic action.

It will be seen then that without doubt the principle Vogel contends for might explain the phenomena. He, however, found that if the silver bromide film had been prepared with an excess of bromide, that the actions indicated did not take place. This seemed to indicate a weak spot in the theory, and it pointed at first sight to the idea that it was necessary to form a coloured compound of the dye with silver, in order to render it sensitive. In the majority of cases this still seems to be, if not a necessity, yet a cause of increase of sensitiveness to the region of the spectrum absorbed. Vogel, however, shows that, if the silver bromide film, prepared with an excess of bromide, be washed, and be then treated with a dye, and a chemical sensitiser, such as tannin, that the same action takes place. The theory of a silver compound in this case must evidently be abandoned, and would point to

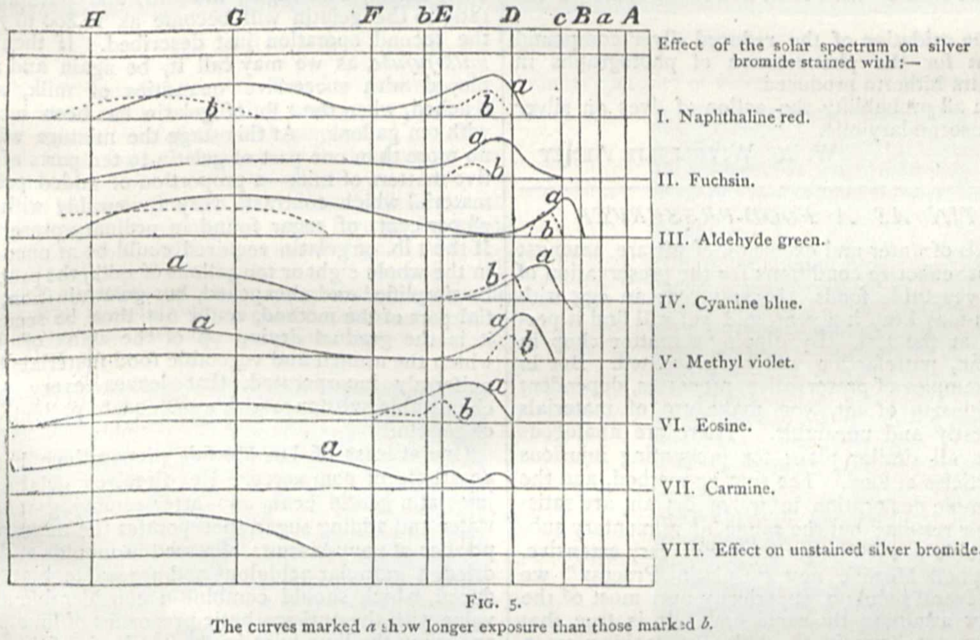


Fig. 5.

The curves marked *a* show longer exposure than those marked *b*.

the correctness of Vogel's theory, did not other experiments in a certain degree offer an explanation more accordant with our preconceived ideas. Let the dye be mixed with *plain* collodion and a film of it be exposed to the spectrum, it will soon be visibly evident that there is a marked effect produced by the rays absorbed. Thus cyanine blue will be found bleached in the region near D and below it. If over the dyed film of collodion thus exposed, a film of silver bromide in collodion be poured in the dark, and the alkaline developer be applied gradually, a silver image of the altered portion of the dyed collodion film will make its appearance, although the film of silver bromide has received no impression by light. The explanation of this remarkable phenomenon is to be found in the theory of alkaline development already given in these articles. The reduced dye acts as a nucleus on which the metallic silver will first adhere, and this first reduction of metallic silver determines the position which the further reduced silver shall occupy, and thus the image is built up. When there is an excess of soluble bromide in the film the developing action will be retarded. This series of experiments seems, then, to indicate that there is no need for optical sensitisers to alter the oscillation of the molecules or molecular groups, but that, in some instances, the same theory may be applied to the action of dyes as may be applied to the deposition of metallic silver on a glass plate which has not been freed from "dirt," a disagreeable phase which is well known to photographers at large. The explanation of the diagram is, therefore, not hard to understand when viewed in this light. The theory of rendering the silver salt sensitive to the red has already been explained, and the same explanation is naturally applicable to those dyes which, when brought in contact with silver, form a definite compound with it.

There are many interesting physical researches which spring out of these various experiments, amongst which may be mentioned a method of determining the size of atoms and their arrangement in the molecule, and last and not least, the production of permanent photographs painted in natural colours by light itself. The attempts made of late to form photographs in proper colours by taking distinct negatives through blue, through green, and through red media and then printing positives from such, and finally obtaining red, green, and blue prints and superimposing them, is not a step in a scientific direction, since it is utterly impossible to secure monochromatic colours which are pure enough to give the truth of nature. Such efforts, though they may be commercially valuable, yet are not to be followed with too much zeal by scientific photographers.

We may now axiomise the results we have indicated:—

1. That the undeveloped photographic image on a silver compound is formed by the reduction of that compound.

2. That the compound may exist in two (or three) molecular groupings.

3. That the compound can only be sensitive to the rays which it absorbs.

4. That the reduced silver compound may be rendered incapable of development by combining with oxygen.

5. That light of every refrangibility may cause an acceleration of oxidation provided the compound acted on absorbs such light.

6. That the oxidation of the compound reduced by any particular ray may be as rapid as the reduction, and thus to give a false idea of their limit of sensitiveness to the spectrum.

7. That the oxidation of the reduced silver compound may account for the phenomenon of photographs in natural colours hitherto produced.

8. That in all probability the action of dyes on silver bromide is a secondary one.

W. DE WIVELESLIE ABNEY

GELATIN AS A FOOD-PRESERVER

REMOVAL of water and exclusion of air are amongst the most effective conditions for the preservation of animal and vegetable foods. If you coat an egg with collodion you may keep it a year, and yet will find it perfectly sound at the last. By dipping a mutton-chop in melted paraffin, putrefaction will be prevented. But in both these examples of preservative processes, dependent upon the exclusion of air, you make use of materials which are costly and uneatable. There are analogous drawbacks to all similar plans for preventing injurious changes in articles of food. The tinning method, and the method of simple desiccation in warm dry air, are satisfactory in their results; but the range of alimentary substances amenable to such treatment is not very extensive. In Dr. Campbell Morfit's new "Gelatin Process" we seem to see several points of superiority over most of the older plans for attaining the same end. It is true that chemists have not been in the habit of looking upon gelatin (or indeed any other similar complex nitrogenous body) as likely to prevent or arrest decay. On the contrary, few solutions afford a more suitable *nidus* for the development of fungoid germs than a liquid containing gelatin. But the experience of a good many months tends to show that food-preparations containing gelatin, if once dried so as not to contain more than 10 or 12 per cent. of moisture, do not become mouldy even when exposed to warm and moist air. A large number of Dr. Morfit's experimental mixtures have been so exposed for some weeks, lying on my office table: yet they have not suffered any decided deterioration. They comprise many perishable foods, such as cabbage, tomato, milk, and meat. Though not of equal merit as specimens of the gelatin process, all are edible, and some positively palatable. Further experiment will doubtless enable the inventor to improve his process by modifying it still further, so as to suit a greater variety of vegetable and animal foods.

Perhaps the best way of explaining the nature of Dr. Morfit's invention will be to take as an illustrative example the case of milk. The mere drying-up of milk has been tried with but moderate success—the resulting powder becoming quickly rancid on exposure to the air. The preserved or condensed milk now in such extensive use is in many respects a satisfactory and convenient preparation, but it is mawkishly sweet, containing more than one-fourth its weight of added cane sugar. Moreover, in consequence of this addition, the proportion of nitrogenous or flesh-forming substances in it has been seriously lowered. Now the substitution of gelatin for cane sugar in preserving milk meets both these objections to ordinary condensed milk. The milk preserves its natural and moderate degree of sweetness, while the gelatin, even if its own value as a nitrogenous nutrient be not considered, certainly does not *lower* the proportion of flesh-formers to heat-givers in the product.

In order to apply his process to the preservation of milk, Dr. Morfit directs us to dissolve 1 lb. of gelatin in 1 gallon of milk at a temperature of 130° to 140° Fahr., and then to allow the solution to set into a jelly; this is then cut into slices and dried. By employing the product of this first operation in lieu of fresh gelatin, for gelatinising a second gallon of milk, a jelly is obtained in which the milk-solids are just doubled in amount. As a gallon of milk contains about 6,400 grains of these solid nutrients, casein, milk-sugar, milk-fat, and phosphates, their ratio to the gelatin will become as 12,800 to 7,000 after the second operation just described. If then the dried *milk-jujube*, as we may call it, be again and again employed with successive quantities of milk, a limit is reached, when the 1 lb. of gelatin has been incorporated with ten gallons. At this stage the mixture will contain no more than one part of gelatin to ten parts of the nutritive matters of milk—a proportion of added preservative material which contrasts very favourably with the 25 to 28 per cent. of sugar found in ordinary preserved milk. If the 1 lb. of gelatin required could be at once dissolved in the whole eight or ten gallons of milk, the process would be simplified and cheapened, but gelatinisation, an essential part of the method, could not then be secured. For it is the gradual drying up of the slabs of jelly, with which the animal and vegetable food-materials have been uniformly incorporated, that leaves every particle of changeable substance with an adequate protective coating of gelatin.

One at least of Dr. Morfit's preparations has become an article of commerce. He dissolves gelatin in lime-juice at a gentle heat, and after removing much of the water and adding sugar, incorporates the mixture with the powder of navy-biscuit. Pressed in moulds and carefully dried, a granular acidulous and agreeable biscuit is produced, which should combine a considerable alimentary value with the anti-scorbutic properties of lime-juice. On analysing the lime-juice jujube, the basis of these biscuits, I find about 8 per cent. of water, 8 of gelatine, 5 of free citric acid, much sugar, and less than 1 (0·7) per cent. of mineral matter or ash. This proportion of gelatin is rather high when compared with the free citric acid, the characteristic ingredient of lime-juice; but the sample analysed was made in April, 1877, and may not represent the exact composition of the recent product. And it becomes a question, whether for travellers' use, it would not be advisable in this preparation to neutralise a little of the acidity of the lime-juice with potash, rather than to mask its presence by an excessive quantity of sugar. Pure lime-juice itself contains very little potash and phosphoric acid or other mineral matter; but that fact affords no argument against the introduction of small quantities of these compounds into such a preparation as that now under consideration.

It would be impossible to discuss in detail the applicability of the gelatin process to the preservation and concentration, in an uninjured, compact, and available form, of fruits, of meat, of cheese, &c., &c. But it may be safely affirmed that Dr. Morfit's invention has already been successfully applied in several directions, and that it is full of promise for the future.

A. H. CHURCH

ELECTRIC DISCHARGE IN GASES[1]

II.

THE form of point most favourable to the production of the arc has been minutely investigated by the authors. By turning wires in a lathe to various outlines they arrived experimentally at the best point; this was then placed under the microscope and drawn by means of the camera lucida; from the study of the drawing it was ascertained that the longest spark was procured when the point assumed a form resembling a paraboloid; the curved out

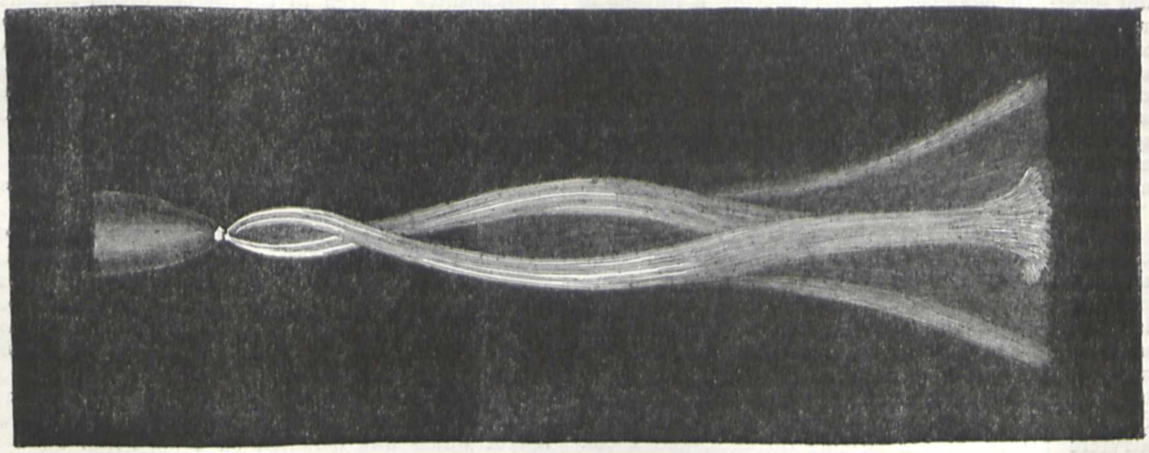


Fig. 8.—"Streamers."

line, which corresponded to that found experimentally, was one in which each succeeding ordinate was in the ratio of the square root of the odd numbers 1, 3, 5, &c., the sectional areas being consequently in the ratio of the odd numbers.

The curves in the diagram (p. 528) show the distances at which, with a given potential, the arc is formed between such a point and a disc, and between two such points respectively. The results recorded in the case of the point and disc are those obtained by electrifying the point to the sign (positive or negative) which gave the greatest length; for it was found that with low potentials the distance at

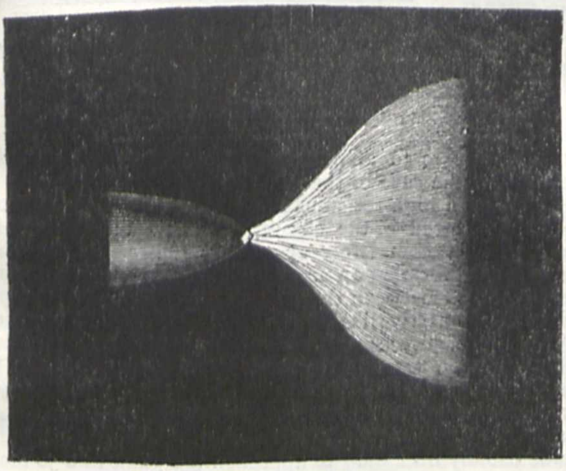


Fig. 9—"Glow."

which the arc forms is greater when the point is *negative*, that between 3,000 and 5,000 volts it is the same whether the point be positive or negative, but that with potentials higher than 5,000 volts it is greater when the point is *positive*.

The actual formation of the arc, when a point and disc or two points are employed as terminals, is preceded by a luminous discharge (streamers and glow), presenting phenomena of an interesting character; an extremely minute quantity of electricity passes as compared to that

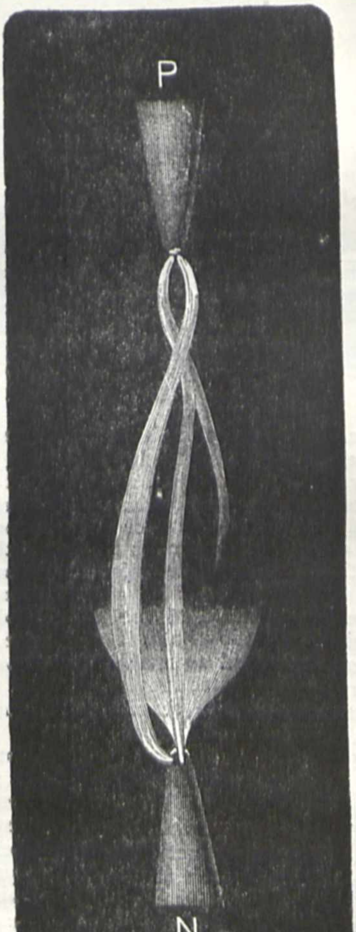


Fig. 10.—"Streamers and Glow."

when the arc is formed, but still it is sufficient when

[1] Continued from p. 528.

caused to pass through a vacuum tube to illuminate it strongly.

"The discharge from the point, when positive, has mainly to the naked eye a stream-like appearance, consisting of a waving line of light surrounded by a very faint sugar-loaf luminosity, and producing a rattling or strong hissing sound; from the point when negative it consists of a glow of light paraboloidal in form, and extending from the point to the disc, but much more brilliant at the point, the noise of the discharge being much less than when the point is positive. The disc, especially when positive, soon becomes covered with a peach-like bloom, and the deposit assumes the appearance of Newton's rings.

"Small as this current is, it is, nevertheless, very manifest from its brightness and the rattling, or loud hissing noise it produces; it frequently continues for some minutes before the spark actually jumps between terminals placed at the striking distance asunder; the streamer-discharge becomes brighter just before the jump and formation of the arc, and this suggested the possibility of particles being carried off in increasing quantity from the point to the disc, and thus contributing to the production of the spark. In order to test this hypothesis, the terminals were placed at the striking distance, and a continuous blast from a blowpipe bellows sent between them; this did not, however, have any effect on the length of the spark, but it deflected the arc when once it had formed.

"Under the microscope the discharge, from the point when positive, is seen to consist of several streams of light, which twist round each other like loosely-bound strands, as shown in Fig. 8, representing the discharge between the terminals, a point and a disc, in a horizontal discharger. Part of the discharge from the point negative is shown in Fig. 9. Fig. 10 shows on a scale of 4 to 1 the phenomenon obtained with 11,000 cells, the streamers and glow proceeding simultaneously from the opposite points of a vertical discharger and existing independently of each other."

In order to study these discharges the authors constructed a microscope (Fig. 11) with a revolving mirror placed at an angle formed by the two tubes composing the body of the microscope, which is bent for the convenience of observation. That part beyond the upright is formed of ebonite, in order to protect the eye from accidental shocks. The discharger used when this microscope was employed was horizontal, as seen in the figure, in order to permit of the employment of the mirror which was mounted on a horizontal axis; the point P was placed in the fixed upright, and the disc D in that upright which is attached to the adjustable slide. The screw S′ is used to approach or recede the microscope in order to adjust to focus; S″ to bring the point horizontally, and S to elevate or depress the microscope by means of a pinion and rack to adjust the point vertically in the field. O is the object-glass and E the eyepiece; W a multiplying-wheel giving five revolutions of the mirror for one turn of the handle, which may be rotated with ease 200 times in a minute, so that the mirror can be caused to make 1,000 revolutions in a minute, or about seventeen revolutions in a second. The whole framework of the stand is of ebonite, to ensure insulation.

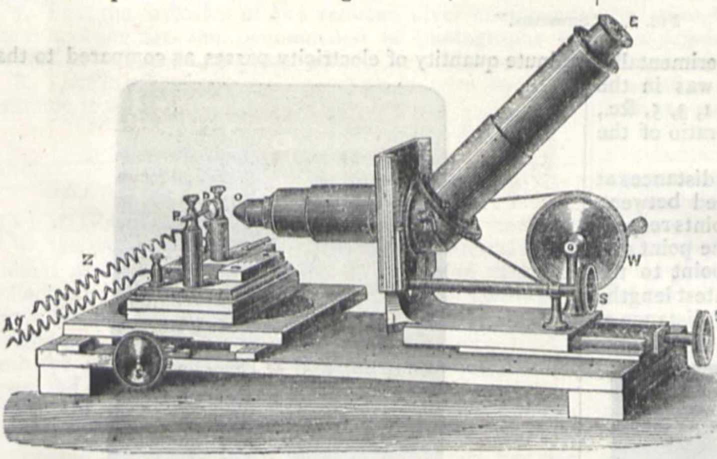


FIG. 11.—Microscope with Revolving Mirror.

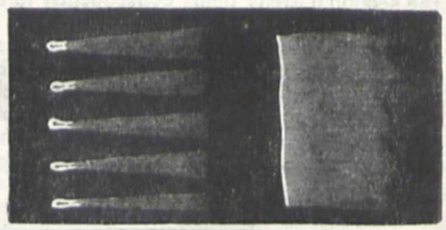


FIG. 12.—Analysis of Streamers and Glow.

"When the revolving mirror was set in motion it was seen that the streamer-discharge was in reality, to a great extent, intermittent. At times a moderate rotation-velocity of the mirror served to show this by the production of a number of distinct images, as seen in the left-hand drawing in Fig. 12; at others it required the full speed of the mirror. The discharge appeared much more continuous with the point negative: so much so that the image was generally seen in the microscope as a sheet of light brightest near the point, and nearly uniform in a direction at right angles to the axis of the mirror. The right-hand drawing shows the appearance when the point is negative. The difference in the sound emitted when the point is positive and negative respectively appears to afford an additional proof of less continuity in the case of the positive.

"When a high resistance—four megohms, for example—was inserted in the circuit, the character of the discharge was completely changed. Instead of jumping across and forming an arc, a series of brilliant snapping sparks pass between the terminals at more or less rapid intervals, exactly like the sparks from a small Leyden jar; these pierce a piece of writing paper interposed between the terminals, producing minute holes. The spark does not jump at the full distance when the four megohms resistance is inserted; and, to produce an almost continuous succession of intermittent sparks, it was usually necessary to approach the point to 0·30 inch, when, without resistance, the spark with 8,040 cells would jump and form the arc at 0·34 inch."

When charcoal terminals were used the jump of the spark was about the same as with other terminals having a similar shape; the charcoal points could be separated when 8,040 cells were used to 1·25 inch generally, and occasionally to 1·5 inch, without breaking the arc. The arc presented the ordinary characters, as shown in Fig. 13; but that which takes place when the terminals are vertically one over the other is different, on account of its being undisturbed by upward air currents which deflect the arc.

The length of the spark differs in various gases at ordinary atmospheric pressures, but the authors found that the difference in the length of the spark does not bear any precise ratio either to the specific gravity of the gas or its viscosity in reference to mechanical impulse; they propose to ascribe it, at all events provisionally, to a difference of *electric viscosity*. In order to make experiments on the dge ischarin different gases, they placed the

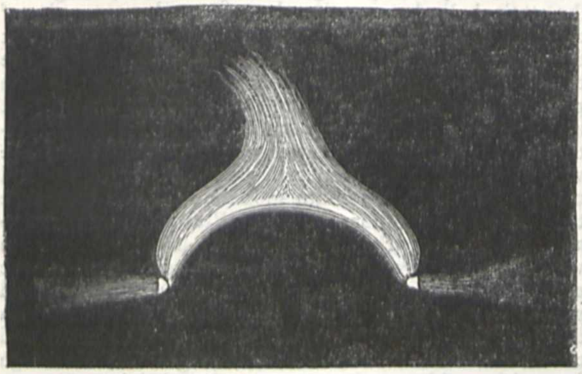


FIG. 13.—Arc between Charcoal Points.

discharger already described (Fig. 4), under a bell glass G G′ (Fig. 14) open at the top and covered with a glass plate P. The glass plate had two screw-clamps which were connected at its under surface with wires led from the screw-clamps *c* and *c′* of the discharger. In connection with these, on the outside surface, were two other screw-

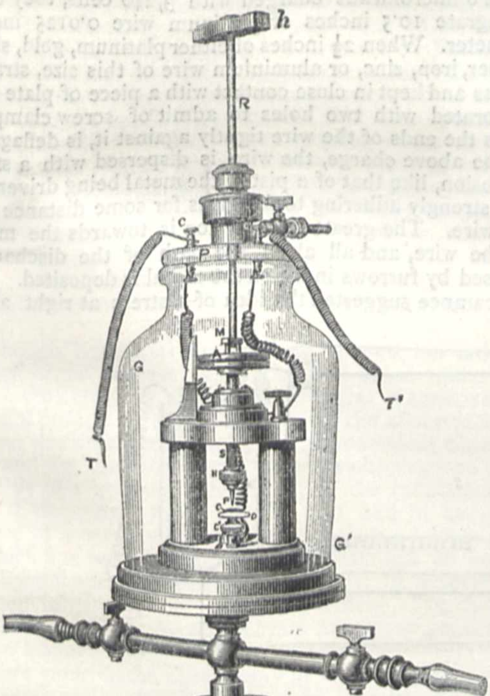


FIG. 14.—Apparatus for Measuring Length of Spark in Different Gases or at Different Pressures.

clamps *c c′* with which the terminals of the battery T T′ were connected. Through a stuffing box in the glass cover a steel rod R passed; this, below the glass, carried a crutch M, with two ebonite pins, which drop into corresponding holes made to receive them in the micrometer wheel A; the rod had on the top, outside the jar, a cross handle *h* for turning it. The distance of the terminals was easily regulated by means of this rod, as the micrometer could be read through the bell glass. Before admitting any gas into it, the bell glass was exhausted by the mercurial pump to a pressure of less than a millimetre, then filled with dry gas, and again exhausted and recharged. The following table shows the results obtained with spherical surfaces 1·5 inch in diameter and 3 inches radius.

Gas.	Length of Spark.	Ratio of Length of Spark.		Ratio of "Electric Viscosity."	
		Referred to Air.	Referred to Hydrogen.	Referred to Air.	Referred to Hydrogen.
	Inch.				
Air	0·082	1·000	0·547	1·0000	1·828
Hydrogen	0·150	1·829	1·000	0·5467	1·000
Oxygen	0·082	1·000	0·547	1·0000	1·828
Carbonic anhydride	0·077	0·939	0·513	1·0650	1·949

The appearance of the arc was different in different gases, as will be seen in Fig. 15, where 1 represents the arc in air; this when examined with the microscope pre-

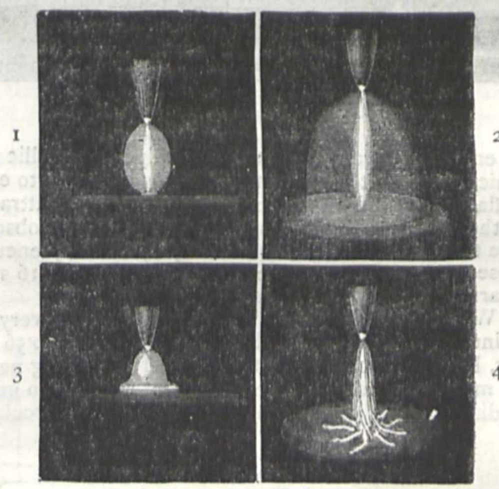


FIG. 15.—The Arc in Different Gases.

sented an evidently stratified appearance, especially in the barrel-shaped surrounding of the central bright spindle; the laminæ were extremely close and seen with very great difficulty, even with the revolving mirror of the microscope; with a moderate magnifier, a hand lens, the barrel-shaped surrounding appeared as if shaded with lines across it.

The arc in hydrogen, with the point positive, is shown in 2, Fig. 15; the central spindle was surrounded by a beautiful blue halo like a glass shade illumined by fluorescent light, and very brilliant on the disc. With four megohms resistance in the circuit, the streaming discharge from the point positive, at 0·502 inch distance, was carmine in colour. This distinctive colour is a proof that the gas in which the discharge takes place is the carrier of electrification in the streamer discharge. The appearance of the arc when the point is negative is shown in 4, Fig. 15; it moved about very rapidly and formed a star-like appearance on the positive disc; when the point was negative, before the jump of the spark, a very pale glass-shade-like halo, of a saddened olive tint extended from the point almost to the outer periphery of the disc.

The arc in nitrogen was reddish violet, and in oxygen it presented an appearance similar to that in air. The arc in carbonic anhydride is shown in 3, Fig. 15.

In the course of their experiments several curious and interesting phenomena were noticed incidentally. A slip of dry glazed note paper, when placed upon the disc of the discharger (Fig. 4), the other terminal being a point, was attracted to the disc so as to require a lateral pull amounting, in some cases, to as much as 30,000 grains, to cause it to slide over the disc: this lateral strain was reproduced when the paper was pressed against the disc by a weight of 129,690 grains. We must refer our readers to the original memoir itself for the full discussion of this phenomenon.

When the terminals were placed opposite to two gas

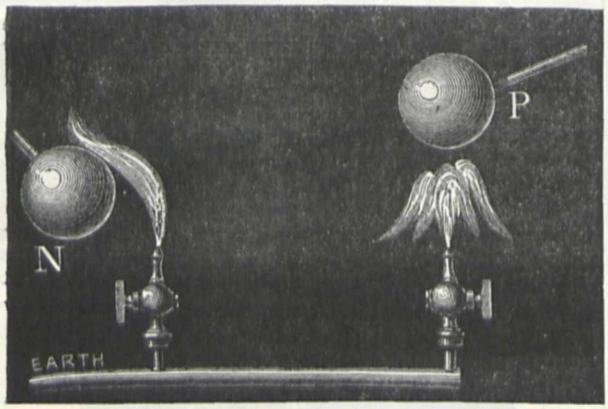


FIG. 16.—Repulsion of Gas-flame.

jets emanating from the same gas pipe in metallic communication with the gas main, and consequently to earth, the flame opposed to the negative terminal is attracted, but that opposed to the positive *repelled*, as was observed to be the case with static electricity by M. Neyreneuf, at whose request the experiment was made. Fig. 16 shows the arrangement and effects observed.

"When one of the terminals consisted of a very fine platinum wire 0·002 inch diameter and about 0·56 inch long, held in a holder like that used for holding needles in a mathematical instrument box, but adapted to go into the discharger, the wire took up a straight, circular, or elliptical oscillation, the glow at the point forming a continuous line of light marking its course; with the point positive the excursion was less than when negative, being with a potential of 8,040 cells, and a distance between the terminals of 0·32 inch, about 0·375 inch; with the point negative it was much more brilliant and about 0·8 inch. By interposing a resistance of 4 megohms the statical discharge took place from the extremity of the wire, frequently producing a beautiful and brilliant figure by the apparent crossing and interlacing of the bright lines of discharge from different points in the path of the oscillating wire; these occurred at such short intervals that the discharge looked like a persistent pattern of intricate engine-turning. By approaching the wire cautiously it was generally possible to cause the end of it to fuse into a minute globule, and the discharge then became much more striking. With 4 megohms resistance the static spark was longest and brightest when the wire was negative; if the wire was very straight, the oscillations took place in a cycloidal curve in a vertical plane, the discharge occurring at equal distances from the middle of the path as the minute globule at the end of the wire attained the limit of the greatest discharge from either side, so that two streaks of light were seen continuously; if the wire was slightly bent, the oscillation was conical or elliptical, and the figure produced by the discharge was then much more continuous and beautiful, because the distance from the point to the plate remained nearly constant."

Another point studied by the authors was the deflagration of wires of different metals. With their condenser of 42·8 microfarads charged with 3,240 cells, they could deflagrate 10·5 inches of platinum wire 0·0125 inch in diameter. When $2\frac{1}{2}$ inches of either platinum, gold, silver, copper, iron, zinc, or aluminium wire of this size, strained across and kept in close contact with a piece of plate glass perforated with two holes to admit of screw clamps to press the ends of the wire tightly against it, is deflagrated by the above charge, the wire is dispersed with a strong explosion, like that of a pistol, the metal being driven into and strongly adhering to the glass for some distance from the wire. The greatest dispersion is towards the middle of the wire, and all along the path of the discharge is crossed by furrows in which the metal is deposited. This appearance suggested the idea of a stress at right angles

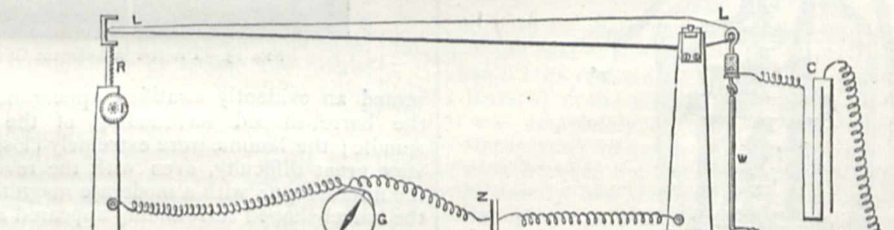


FIG. 17.

to the path of the discharge which might involve a notable longitudinal contraction.

An experiment was made to test this hypothesis, but the results were entirely negative. When the key K (Fig. 17) was pressed down the accumulator C was discharged through the wire W, which was 8 inches long, and of diameters varying from 0·2 to 0·0125 inch; if now the wire had, at the moment of discharge, contracted longitudinally by $\frac{1}{13000}$ inch, the fact would have been recorded by the deflection of the galvanometer G, in consequence of the closing of the circuit of the battery Z, at the extremity of the long arm of the lever; with this apparatus, however, the contraction, if it occurred, was not detected; the extremity of the lever was not observed to rise before it descended in consequence of the elevated temperature of W; after W had been allowed to cool down to its original temperature, the extremity of the lever remained slightly below its original position.

Only a few experiments have as yet been made by the authors on the length of spark at different pressures below that of the atmosphere, but they intend to pursue this investigation with a micrometer discharger of longer range than that shown in Fig. 4.

With two spherical surfaces, each of 3 inches radius of curvature and 1·5 inch diameter, the following results were obtained with 8,040 cells:—

Pressure.	Fraction of an atmosphere.	Length of spark.	Ratio to length at 1 atmosphere.	Ratio of length of spark to dilatation.
Millims.		Inch.		
760	$\frac{1}{1}$	0·079	1·00	$\frac{1}{1} = 1·000$
602	$\frac{1}{1·262}$	0·100	1·26	$\frac{1·26}{1·262} = 0·999$
414·7	$\frac{1}{1·833}$	0·200	2·52	$\frac{2·52}{1·833} = 1·375$
299·5	$\frac{1}{2·537}$	0·400	5·04	$\frac{5·04}{2·537} = 1·986$
141·5	$\frac{1}{5·370}$	0·800	10·08	$\frac{10·08}{5·370} = 1·876$

ERNEST QUETELET

THE death of M. Ernest Quetelet, "chef du service Astronomique" of the Observatory of Brussels, took place at Ixelles on the 6th instant, after a long and painful illness. His connection with the observatory dates from 1855, when he entered it as an assistant to his father, the late Lambert Adolphe Jacques Quetelet, who was then the director, and who died so recently as February, 1874. Ernest was born in Brussels August 7, 1825. At that time his father was busily occupied in pressing on the king and the municipality of Brussels the importance of establishing an observatory for meteorological purposes. After much discussion and many delays it was determined in 1826 to establish an astronomical observatory; Quetelet was directed to obtain instruments, to visit Paris and London, and on January 9, 1828, he received his official appointment, his title being "astronomer." The three principal astronomical instruments were set up in 1835, but the first four volumes of the *Annales* of the observatory coming down to 1845 contain only meteorological notes. The first volume (date 1834) opens with an "aperçu historique des observations de météorologie faites en Belgique jusqu'à ce jour," commencing with 1763, and shows how thoroughly the director entered into the importance of the work. The observatory in 1845 was the centre of meteorological observing stations, of which there were more than eighty.

Although Ernest, as he grew up, shared his father's interest in the various observations included under the head meteorological, and took terrestrial magnetism as a special subject for study, on joining the observatory in 1855 he was appointed to take the astronomical observations and the *Annales* record that the observations were made by him and the calculations of the reductions by M. L. Estourgies. From 1857 he has had in hand the revision of a catalogue of the variable stars, a large part of which has been published. Two years ago he issued the climatological elements of Brussels, in a series of eighteen tables, for the ten years ending 1873, and in the *Bulletin* of the Société Royale are many papers by him on magnetism.

Before entering the observatory he was in the Engineers for several years, after having passed through the École Militaire of Brussels. In 1848 he was engaged as a subaltern on the work of the fortifications of Antwerp. It was while still in the Engineers he communicated his first paper to the Academy, "Recherches sur les Médianes" (October 9, 1859), which was printed in the *Mémoirs Couronnés*. In 1856, shortly after joining the Observatory, he wrote a paper on the magnetism of the earth in North Germany and Holland, and in 1859, "On the Magnetic Declination at Brussels."

The Observatory has all through its existence had to struggle against difficulties; one of the latest recommendations of the Commission on it was to effect the following improvements:—

"To complete the magnetic system of the Observatory by the acquisition of self-registering instruments, to organise the International Meteorological Service, to obtain an equatorial of large dimensions with the accessories necessary to the spectroscopic investigation of the heavens, and to increase the number and improve the position of the observer."

During many years M. Quetelet has often been appointed referee to the printing of papers in the *Mémoires* of the Académie Royale, and has been himself a frequent contributor.

GEOGRAPHICAL NOTES

IN the Geographical Section of the French Association some papers of interest were read. Dr. Carret read a curious paper on the Distribution of Antipodes, in which the author indulged in some rather fanciful theorising. Gen. Ricci spoke on the geodetic work carried on by the Italian Government, which is energetically completing the triangulation of Italy, connecting it with the rest of Europe on the one side and Africa on the other. Gen. Ricci also spoke of the regular tidal observations carried on at various stations on the coast of Italy, mainly with a view of getting a true level for geodetic purposes. M. H. Duveyrier read an elaborate paper on the remaining problems in African geography, in which he divided unknown Africa into seven great regions: (1) The Sahara and the Libyan Desert; (2) The country between the Joliba and the Guinea Coast; (3) The upper courses of the Binue and Shari; (4) The region behind Cape Guardafui; (5) The equatorial chain of lofty mountains; (6) The completion of the basins of the Nile, Congo, and Ogove; (7) The basin of the Cunene. Altogether more than 11,000,000 square kilometres remain unexplored, more than one-third of the whole surface of Africa. At the mean rate of discovery since the beginning of the century, this might be covered in about forty-eight years, though the ratio is now so increased that it ought to be done in much less time. A paper by M. Maunoir recounted the services done to geography by France since 1800, and when all put together with the eloquence of a Frenchman, they seem formidable.

NEWS from Capt. Tyson's Arctic expedition in the *Florence* has been brought to Washington by the schooner *Helen*, which wintered in the same bay on the coast of Cumberland. Meteorological observations were taken most accurately during winter by Mr. Sherman, the physicist of the expedition. Unfortunately the naturalist inflicted on himself a wound when on duty, and was disabled for the greater part of the winter. Capt. Tyson went to Disco to recruit natives, collect goods, and purchase dogs. He fulfilled his duty with his wonted activity and success. But when everything was ready he learned by a message sent from Washington that the preparations were useless, the American Congress having taken its vacation without deliberating upon the report so carefully drawn by the Marine Committee. The brave and accomplished commander of the *Florence* is now on his way to Washington, where he is expected daily. We are informed that a demonstration will be made against this piece of Parliamentary negligence. This preliminary expedition was entirely fitted out at the expense of Capt. Howgate and his friends.

NEWS has arrived that the Bremen steamer *Neptune*, Capt. Rasmussen, which left for the Ob, in Siberia, on July 16, reached Hammerfest on the 6th instant with a full cargo of Siberian wheat. The *Neptune* was laden with all sorts of mercantile goods. She entered the Nadym on August 13, and had no ice difficulties on the voyage out. Perhaps in future, when the navigation of the estuary of the Ob is better known, the voyage may be made in even a shorter time. Indeed if depôts were established at suitable points on the north Norwegian coast, it might be possible for a ship to make two journeys to Siberia in one summer. Probably the Ob is the most important of the Siberian rivers so far as commerce is concerned. Trade on the Ob is already considerably developed, the river being navigated by over thirty steamers. The region around the river is the most productive and most thickly inhabited in Siberia.

IN an article in the September number of Petermann's *Mittheilungen*, on the chief branches of the Russians, much interesting information is given on the characteristics and distribution of the Great, Little, and White Russians, illustrated by a carefully constructed map. In the same number Dr. Junker, in a letter to Dr. G. Schweinfurth, describes his travels in the south-west part of the Nile Region in January-October, 1877, adding considerably to our knowledge of the region, and making several corrections on existing maps. Lieut. Weyprecht describes the results of his observations in 1871-4, on the temperature and depth of the sea to the east of Spitzbergen. The sea, he finds, is comparatively shallow, seldom exceeding 400 metres.

WE have received a handsome atlas of the State of New Hampshire (U.S.), containing, besides a series of beautifully-executed maps of the state and of its counties, —meteorological, geological, agricultural, and arboricultural,—a vast amount of well-arranged information on its topography, geography, river systems, climatology, railroads, educational institutions, agricultural and botanical productions, mechanical and manufacturing interests, &c. The work is edited by Mr. H. F. Walling, C.E., and Prof. C. H. Hitchcock, and is published by Comstock and Clive, New York. The work is creditable both to the editors and publishers. The long list of "patrons" of the atlas appended—mostly people in business—speaks well for the intelligence of the inhabitants of New Hampshire.

IN a letter to Sir Samuel Baker from a gentleman in the Khedive's service, the latter describes a successful journey which had been made with some Indian elephants in the White Nile region, proving that this powerful and useful animal may be utilised advantageously in African travel and exploration.

OUR ASTRONOMICAL COLUMN

THE INTRA-MERCURIAL PLANET.—In addition to the letter addressed to the Astronomer-Royal by Prof. James Watson, after revising his first position of the object near θ Cancri, more carefully at Ann Arbor, similar communications have been made to M. Fizeau (*Comptes Rendus*, May 2), Prof. Förster (*Circular zum Berliner Astronomischen Jahrbuch*, No. 98), and to Prof. Peters (*Astronomische Nachrichten*, No. 2,217). The definite position is in R.A. 8h. 27m. 24s., Decl. + 18° 16′ for July 29, at 5h. 16m. 37s. Washington M.T., or 10h. 24m. 49s. M.T. at Greenwich, which position Prof. Watson considers to be trustworthy within five minutes of arc, with a greater probable error in the declination than in the right ascension. The other points named by the discoverer, upon which stress is to be laid, are the fact of the star θ Cancri being also observed, the appearance of a sensible disk with a power of 45 on a 4½-inch refractor, its ruddy colour and much greater brightness than that of the neighbouring star. There has never been a suspicion of a variable star in this vicinity, nor can the appearance of a disc be so explained. Prof. Watson seems to have satisfied himself that the object was not a comet; indeed, such a body would hardly appear round and well-defined with the sun totally eclipsed. In the case of the comet of March 1847, which was observed in full daylight, at a similar distance from the sun to that of Prof. Watson's object, two short tails were visible though the head was circular, and the great comet of February, 1843, also exhibited a bifid tail, which was bright and distinct to the naked eye. Mr. Hartnup, who observed the comet of Klinkerfues, 1853, in broad daylight, described it as circular, well-defined, and without tail, but the case is hardly analogous to that of a comet viewed while the sun is wholly hidden.

[Since the above was in type, the full details of Prof. Watson's observations and reductions have been received.]

THE VARIABLE NEBULA IN TAURUS (HIND, 1852). —In the diagram attached to M. Tempel's remarks upon this object in *Astron. Nach.*, No. 2,212, a distinction is made between the position given in No. 839 of the same periodical and that assigned with reference to the neighbouring variable star T Tauri. To prevent misconception on this point it may be well to remark that, on the first night the nebula was perceived with Mr. Bishop's seven-inch equatorial—October 11, 1852—it preceded the variable star 1s.·2, and was south of it 0′·7, as stated in the *Astron. Nach*, and that at no subsequent time when the nebula was observed with the same instrument was any difference of position noticed: it appeared to nearly touch the star on the S.P. side. No. 1 on M. Tempel's diagram should be therefore erased. In a note in his Supplementary Catalogue Mr. Dreyer states that he found no appearance of nebulosity near the well-known variable; nor did Dr. Copeland, observing with the large refractor at Lord Lindsay's Observatory; nor M. Tempel, with a fine Amici of 11-in. aperture, at Arcetri. On the other hand, M. Otto Struve still found traces of nebulosity with the Pulkova instrument, which he "believes is certainly the variable nebula itself, only in altered brightness and spread over a larger space;" and he adds, "some traces of nebulosity are still to be seen exactly on the spot where Hind and d'Arrest placed the variable nebula." The accurate position of T Tauri has yet to be determined by meridional observation. Argelander re-observed Bessel's star of the ninth magnitude, which precedes it 16·5s., about 4′ south.

THE LATE DR. E. VON ASTEN.—By the early death of Dr. von Asten astronomy has lost a most able worker in a branch which has numbered of late years fewer distinguished names than formerly. He was one of Argelander's pupils and intended to apply himself to observations, but, we believe, through a serious accident, he was incapacitated for active occupation, and his desire to devote his attention to astronomy could only be gratified by obtaining employment in calculation. This he was so fortunate as to effect through the director of the Imperial Observatory at Pulkova, M. Otto Struve, who engaged him as one of the staff of computers. In this position Dr. von Asten had for some time carried on a rigorous investigation on the motions of Encke's comet, one of the most interesting results of which has been to prove that while in some revolutions an acceleration similar to that attributed by Encke to the existence of a resisting medium has made itself evident; in others the motion of the comet could be precisely followed without such hypothesis, and hence a different cause might be found for the cases of acceleration. Dr. von Asten previous to his connection with Pulkova, minutely discussed the whole of the observations of the great comet of Donati (1858 vi.), arriving at the conclusion that at the time it was visible it was moving in an elliptical orbit with a period of nearly 1,900 years.

NOTES

THE Association of German Naturalists and Physicians commenced its sittings at Cassel on Wednesday last week, and judging from the numbers of the *Tageblatt* and of the Cassel papers that have been sent us, the meeting has been quite as successful as usual. Every provision had been made by the local authorities for the reception of the Association, and while abundance of serious work has been done, a fair proportion of the time has been given to enjoyment. Among the arrangements, for example, are performances of "Faust," "Midsummer's Night's Dream," "Comedy of Errors," "Tannhäuser," and other classical pieces in the theatre, and among the excursions is one to the Paris Exhibition. The president, Dr. Stilling, in his opening address, traced the history of the scientific life of Cassel, showing that much good work had been done there, and that the names of not a few eminent men of science have been connected with the city. The title of Prof. Oscar Schmidt's lecture seems sensational enough—"Darwinism and Social Democracy,"—but his treatment of it seems to have been quiet enough; he aimed at showing that Darwinism instead of being a leveller, showed the tendency to be everywhere to heterogeneity. Prof. Hueter, in his lecture on the Physician in Relation to Research and Natural Science advocated a longer curriculum for medical students and a more thorough training in science and in the experimental method. The numerous sections were busy enough, and many good papers were read, but any further account of the proceedings we reserve till we have received a complete set of the *Tageblatt*.

IN the terrible panic which has seized the Southern States under the epidemic of yellow fever, we are glad to see that science has been pressed into service and stuck bravely to her post. Every one who can is flying for life, but it has been deemed advisable to retain the sergeants of the United States Signal Service at their posts in order to keep up for the use of the medical men regular observations of temperature, humidity, and other atmospheric phenomena which may have any influence in the spread of the disease. One of these officers died at his post and two others had been struck down, probably also fatally, as we learn from the New York *Tribune*. It is encouraging to see that the United States authorities have kept their heads clear enough to perceive that the services of science are indispensable to "the healing of the nations."

M. BISCHOFSHEIM, the well-known Parisian banker, has sent a sum of 10,000 francs to the French Bureau Central Météorologique to help in the construction of the intended Mont Ventoux Observatory. We may remind our readers that he, at the suggestion of his friend M. Leverrier, helped in the same manner the construction of the Puy-de-Dôme and Pic-du-Midi establishment. M. Bischofsheim has also agreed to pay M. Eichens 1,000*l*. to complete within a year the construction of the great refractor begun in Leverrier's time in 1870.

THE fitting up of the Lyons Observatory is progressing favourably; the inauguration will take place in a few weeks.

WE noticed with regret a few weeks ago that a tax had been imposed on the French communes to entitle them to receive the daily meteorological telegrams of the Bureau Central. A new delay has been granted for the subscription, and we are happy to state that a large number of rural parishes, fully appreciating the importance of the service rendered by the telegraphic warnings, have already agreed to pay the yearly charge, which has been reduced to forty francs.

M. COCHERY, the director of the French postal telegraph, is now in London studying the working of the English system and hopes to introduce into the French service a number of improvements which the large traffic and progressive character of the English service has brought into use.

THE meeting of the Iron and Steel Institute opened at Paris on Monday, with a presidential address by Dr. C. W. Siemens, who showed how comparatively well provided France is with institutions for scientific education, and referred briefly to the work carried on at some of the great industrial centres. We have already given a list of the papers to be read, all of them of more or less technical bearing.

THE fourth Congress of Orientalists commenced its sittings this year at Florence on the 12th inst. The chief nationalities have been well represented, and the reception by Florence and by Prince Amadeo has been hearty. One attractive feature is an extensive exhibition of objects connected with the subjects with which the Congress deals.

THE Fourth Annual Conference of the Cryptogamic Society of Scotland, will be held at Edinburgh on October 9, 10, and 11. The programme includes excursions, a dinner, and an exhibition of fungi. The meeting-place is the Botanic Gardens of Edinburgh, the president is Prof. Balfour, and the secretary Dr. Buchanan White, Perth.

AN agricultural exhibition took place at Lockwitz, near Dresden, on September 5–7. It formed part of the general meeting of the Saxon Agricultural Society which enjoys the special patronage of the King of Saxony.

THE Congress for 1878 of the German Viticultural Society was held at Würzburg on September 15–19.

GREAT activity continues to be manifest in Vesuvius, and volumes of lava are projected to a height of 100 yards above the new crater, accompanied by loud explosions. However, no flames are yet visible.

SINCE M. du Moncel presented the Edison phonograph to the Academy of Sciences electrical inventions of every description are sent to him for presentation. A large number of these deserve notice, and no sitting passes without M. du Moncel speaking on two or three different inventions. This state of things has created some anxiety amongst members unable to understand electrical matters. On Monday week one of them proposed to the president that M. du Moncel be obliged to execute all the experiments he was describing before the Academy, in order to prove whether they were sound. M. du Moncel replied that he was himself verifying them with much care, but that a number could not be executed before the learned assembly, as two different stations, situated at a great distance, were required; and he reminded them that, when he brought the phonograph before the Academy, he had taken the precaution to procure an able operator for the working of it. The point of the reply is that a certain number of the members said that the phonograph was exhibited by a ventriloquist. M. Fizeau, who was in the chair, called the assembly to a vote, and the discussion ended. It was not recorded in the *Comptes Rendus*.

AT the meeting of the Botanical and Horticultural Congress in Paris, the following were among the most interesting communications and discussions:—On the influence of the age of seeds on the plants raised from them. Prof. Baillon found that Prof. Cazzuole's view, that the newer the seeds of *Cucurbitaceæ* the larger the proportion of male flowers, and *vice versâ*, was not confirmed by his own experiments, in which he had sown melon-seeds dating from 1870, and for comparison last year's seeds.—On double flowers. Prof. Morren, in support of his well-known theory of the incompatibility of truly variegated leaves and double flowers, pointed out that in the camellia and *Kerria japonica* normal flowers are only known to occur on variegated stocks. In a Hibiscus, which unites these peculiarities, the flower-buds fall without opening; in a variegated and double wallflower, many of the branches revert and are quite green.—Descriptions were given of the chief botanical laboratories in St. Petersburg, Amsterdam, Florence, and Paris.

In the last city there are no less than four in active work, viz., those of the Sorbonne, École de Médicine, École de Pharmacie, and Muséum (Jardin des Plantes) respectively, besides one for experimental physiology at Vincennes.—On the question of gymnospermy. Prof. Arcangeli's anatomical researches had led him to conclude that the coat of the ovule in Gymnosperms was sometimes carpellary in origin, but not always. Unfortunately no discussion followed.—M. Sirodot gave an abstract of his researches on *Batrachospermum*, which he shows is the sexual form of *Chantransia*.—M. Borodin gave an account of the variations in the excretion of CO_2 in leaves of different ages. —M. Millardet found the lesions from phylloxera differ according as the part attacked is the young rootlet or an older part. In the latter case a septum of cork is often formed to preserve the parts that remain healthy. Unfortunately the question of the "Hortus europæus" was hardly discussed, but suggestions were made for the compilation of a new "Steudel." Besides the excursion to Segrez, a large number of members were conducted, on the 22nd, all over the remarkable irrigation works at Genevilliers (where a fourth of the sewage of the city of Paris is utilised), by M. Durand-Claie, Engineer to the Works, and M. H. Vilmorin, Secretary to the Commission d'Etudes. Afterwards many of the foreign members breakfasted with M. E. Cosson, and visited his splendid herbarium, and in the evening was held the banquet of the Congress. On the 23rd a large party visited the gardens of the Jardin des Plantes with Prof. Decaisne, and the herbarium with Prof. Bureau. The final session of the Congress was held at Versailles on the 25th, after which the members visited the show of the Horticultural Society of the town, at whose annual banquet the foreign members were entertained in the evening.

A VERY useful paper "On Lightning Conductors and Accidents by Lightning" was read at the British Association meeting by Richard Anderson, F.C.S. So slow has been the "march of progress" in the application of one of the greatest scientific discoveries of modern times to the uses of daily life, that even now, after the lapse of more than a century, the employment of lightning conductors, simple as they are, and as inexpensive as simple, is far from being general, still less universal. At least one-half, and perhaps two-thirds, of all the public buildings, including the churches and chapels, of Great Britain and Ireland, are without protection against lightning. As to private houses, it is safe to assert that not five out of every hundred have lightning conductors. It is well known that the amount of property destroyed annually by lightning is very great, though it is naturally impossible to form any estimate of it. The terrible losses, both of property and human lives, still occasioned by lightning, are the more lamentable, as they are in nearly all cases the result of the grossest negligence. The negligence is three-fold—namely, first, in not providing any lightning conductors at all; secondly, in not placing them in the right position, or in sufficient number to cover a given area; and, thirdly, in not having them regularly tested, so as to ascertain their constant efficiency. Even some of the first cathedrals of England, such as Peterborough, have no lightning conductors whatever, while others, supplied with them, are insufficiently protected, as is apparent to any competent observer. Mr. Anderson gives striking examples of the absence of lightning conductors, and of the disastrous effects of their being badly placed. The third cause of neglect is by no means the least. Mr. Anderson justly argues that lightning conductors ought to be at regular intervals, at least once a year, carefully inspected, and their efficiency tested by a galvanometer. The absolute neglect of this precaution which is now prevailing is no doubt the cause of a vast number of casualties by lightning, inflicted upon buildings nominally protected by conductors. Utter neglect of the conductor, when once it has been put in its place, is the commonest thing, and indeed the rule, as regards private dwellings; and, we fear, there is little difference in this respect as to most public buildings, churches, and chapels. In fact, it is the old case of a matter of however great consequence, yet being utterly disregarded as "nobody's business." Between three and four thousand pounds were spent in protecting the Houses of Parliament by lightning conductors at the time of their erection, some twenty years ago. Since that time, as far as Mr. Anderson can learn, after minute investigation, they have never been tested, and there is no guarantee whatever that a discharge of lightning may not at any time fall upon the Queen's throne, the Lord Chancellor's woolsack, or the Speaker's chair. A French writer pithily expresses the results that follow from a lightning conductor over a house not having a proper "earth connection," by saying it is lightning guided to the owner's iron bedstead. Mr. Anderson then gives several useful practical instructions as to what ought to be done to amend the present unsatisfactory state of matters, which well deserve attention. As the clock in churches and other public buildings is methodically inspected by the clockmaker, so ought every lightning conductor to be as systematically examined by an electrician or other competent person. Already such a system of inspection and testing of conductors exists in Paris and several other French towns. Shall we say, once again, "They manage these things better in France?"

THE long-expected report of the United States Entomological Commission, appointed to investigate the ravages of the locust, has been published as one of the series of Dr. Hayden's survey, and constitutes a very important addition to the scientific and practical literature on this subject. Although it has been several years since there has been any serious damage caused by the Rocky Mountain locust, their enormous destructiveness, when they do occur in abundance, is such as seriously to threaten the prosperity of the States in which their ravages are prosecuted. The present report professes to be for 1877, and posts the subject up to that date, being a stout volume of nearly 800 pages, and is accompanied by excellent wood-cuts and engravings, representing the insect and its winged and other enemies in all stages of development and condition. In addition to the descriptions of the species and its general natural history, various remedies and devices for its destruction are communicated; also notes on the influence of prairie fires on the increase of the locust, the influence of the weather on the species, the effects which generally follow severe locust injury, and the uses to which locusts may be put. There are also chapters on the ravages of other species of locusts in the United States and on the ravages of locusts in other countries. Congress at the last session provided for the continuation of the inquiry for the present year under the same commission.

MR. W. H. SHRUBSOLE informs us that an imperfect tooth recently found in the London clay at Warden, in the Isle of Sheppey, has been submitted by him to Prof. Owen, who says of the specimen that "it suffices to determine both the mammalian and ungulate nature of the animal it belonged to; that it comes nearest to the kind of *Palæotherium* figured in 'British Fossil Mammals,' p. 322, Fig. 116, but is too incomplete to show the genus or species." Mr. Shrubsole adds that there is no record of any mammalian remains having been found in Sheppey before.

MESSRS. CHURCHILL will publish, early in November, a work on the poisonous snakes of India, by Dr. Ewart, illustrated with coloured plates reduced from Sir Joseph Fayrer's large folio work.

MESSRS. TEGG AND CO., Pancras Lane, will shortly publish "Berkeley's Principles of Human Knowledge," with Introduction and Copious Explanations, by Collyns Simon, LL.D., author of "The Nature and Elements of the External World," and Proposer of the Berkeleian Prizes in 1848 and 1850.

A NEW book on Ferns has just made its appearance at Salem, Massachusetts, under the title of "Ferns in their Homes and Ours." Its author is Mr. J. Robinson, Professor of Botany, Massachusetts Horticultural Society, and the book forms one of a series called the "American Natural History Series." It has been put together especially for the use of persons residing in the United States, but the author has nevertheless made himself thoroughly acquainted with the works of European pteridologists and pays a high tribute to those of our own country, notably the more recent works of the veteran John Smith. Though the book commences with a consideration of the life-history of a fern, classification, distribution, and nomenclature, it is for its practical part, dealing with the selection and cultivation of these favourite plants in living, that the book will be most valued.

NEWS from Denmark states that the last pillar of the first fixed bridge across the Lim Fjord has now been finished; the new bridge will connect Aalborg on the south side of the fjord, with Norresundby on the north, and it is hoped that it will be opened for traffic during the autumn. Our readers will remember that the Lim Fjord is an arm of the sea stretching right across the Danish continent from east to west.

SOME interesting excavations have been recently made at the "Limburg," a large ruin near Dürkheim in the Bavarian Palatinate, at the instigation of the German Anthropological Society. During 1877 prehistoric remains had been found at this spot, and the work being continued this year, numbers of urns, human and animal bones were discovered, all undoubtedly of prehistoric origin. The most interesting part of the discovery is the laying bare of a cremation ground.

A PAPER on "The Salt Lakes, Deserts, and Salt Districts of Asia," by Mr. Thomas Ward, read before the Liverpool Literary and Philosophical Society has been published separately, with a map. The author endeavours to illustrate from what is known to be going on in the formation of salt at the present time, the way in which salt was formed in past ages.

THE Rev. Thomas Powell, of Upolu, Samoa, writes us that in vol. xv. of NATURE, p. 503, in our report of the Linnean Society, his paper on "Poisoned Spears and Arrows" is represented as having reference to *Samoa*. Mr. Powell sends us a corrected copy of the paper from which we see that the paper has reference to the New Hebrides. The Samoans, Mr. Powell states, have no such custom as the use of poisoned weapons of any kind. They formerly made use of the bow and arrow, not, however, for purposes of war, but of sport only. The introduction of fowling-pieces has abolished the use of the bow. Another error, Mr. Powell writes, into which we have been led is the statement that *Callophyllum inophyllum* was among the trees whose milky juice was used as a poison. This is not Mr. Powell's statement. His informant said that the *Toto* resembled that tree in general appearance. The *C. inophyllum* is a valuable timber tree in common use. Its flowers and fruit are used in Samoa as a perfume. From its fruit an oil is extracted in Fiji, which is useful as a liniment in rheumatism.

THE additions to the Zoological Society's Gardens during the past week include a Banded Ichneumon (*Herpestes fasciatus*) from West Africa, presented by Mr. F. T. Blackley; two Vinaceous Turtledoves (*Turtur vinaceus*) from West Africa, a Greek Land Tortoise (*Testudo græca*), European, presented by Miss Harris; a Common Adder (*Vipera berus*), European, presented by the Viscount Mandeville; a Spotted Turtledove (*Turtur auritus*), bred in the Gardens.

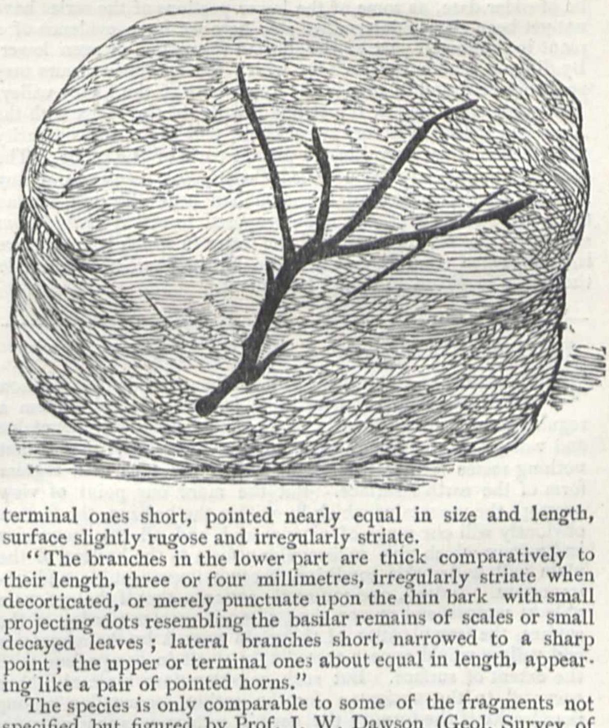
A FOSSIL PLANT[1]

MANY years ago the late Sir William Logan drew attention to the occurrence of fossil plants in the Devonian strata of Canada, and Prof. J. W. Dawson, F.R.S., in the *Quarterly Journal* of the Geological Society, in vols. xv. and xviii., described and figured some of these specimens. Amongst them was a plant which he designated *Psilophytum*. Dr. S. S. Scoville has since discovered the remains of plants in the lower silurians at Longstreet Creek, near Lebanon, Ohio, which Prof. Newberry considered as the casts of some large fucoids or marine plants. Count Saporta has found the branch of a fern in the silurian schists or slates of Angers, France. Prof. Leo Lesquereux, to whom we owe so much for his labours in investigating the fossil plants of the United States, in a paper read before the American Philosophical Society, October 10, 1877, has described and figured a plant from the lower Heldeberg sandstone, Michigan, under the name of *Psilophytum cornutum*.

In a paper read by myself before this society on December 26, 1876, I stated that after some years' search I had not been able to find the *Palæochorda major* mentioned by Professors Harkness and Nicholson as occurring in the Manx schists in such a state of preservation as to be certain of its true nature, but I had a fucoid in my possession found by Mr. Grindlay in the drift near Laxey.

As Mr. Lesquereux's specimen so much resembles the one found at Laxey I shall give his description at length.

"Stem thick, dichotomous, divisions variable in distance, the



terminal ones short, pointed nearly equal in size and length, surface slightly rugose and irregularly striate.

"The branches in the lower part are thick comparatively to their length, three or four millimetres, irregularly striate when decorticated, or merely punctuate upon the thin bark with small projecting dots resembling the basilar remains of scales or small decayed leaves; lateral branches short, narrowed to a sharp point; the upper or terminal ones about equal in length, appearing like a pair of pointed horns."

The species is only comparable to some of the fragments not specified but figured by Prof. J. W. Dawson (Geol. Survey of Canada, Fossil Plants of the Devonian and upper silurian formations, Figs. 243, 244). The author remarks "that these fragments are probably originating in the upper silurian of Gaspé; that as they are found in the lower part of the limestone which underlies the Devonian Gaspé sandstone and become more abundant in the upper beds, this suffices to indicate the existence of the neighbouring land, probably composed of silurian rocks and supporting vegetation."

From the preservation of its branches even to the smallest subdivisions, the specimens here represent part of a plant embedded in the place of its growth. The matrice is a piece of very hard calcareous shale seven to eight millimetres thick, bearing on one side irregular undulations like ripple marks, without any trace of organic remains, and on the other the fragments of plants as figured here. The branch in (*a*) represents a different species,

[1] "Notice of a Fossil Plant found at Laxey, in the Isle of Man," by E. W. Binney, F.R.S., F.G.S., President, paper read at the Literary and Philosophical Society, Manchester.

and indeed a marine or rather a brackish plant, closely related to the species of the present genus *Chorda*, Stack. This fragment seems to have been mixed in the tide pools with fresh water or land plants growing there. For another thick specimen of the same locality and compound bears a profusion of marine mollusks, and has only branches of this as yet undescribed marine species, *Calamophycus septus*.

Habitat lower heldeberg sandstone, Michigan, discovered and communicated by Dr. Carl Rominger (State Geologist).

On comparing my Manx specimen, which was found on the surface in a field at Laxey with that figured and described by Prof. Lesquereux, it agrees with the latter in every respect, except that striæ and scales are not observable on the stem. The stem is thick, dichotomous; divisions variable in distance, the terminal ones short, pointed nearly equal in size and length, surface nearly smooth. The branches in the lower part are thick comparatively to their length. The surface of the stem appears to be smooth and affords no evidence of striæ or scales.

The woodcut on the preceding page represents the specimen a little over the natural size.

The stone in which the plant is embedded is a fine-grained grit of a grey colour, and the specimen itself is of a yellow tint as if coloured by oxide of iron; it runs nearly at right angles to the bedding of the stone, and appears as if standing in the same position as it had grown. The stone is a rolled one but it is evidently from the Manx schists found in the vicinity. These, according to Profs. Harkness and Nicholson, are of the age of the Skiddaw slates, but the rock in which the fossil occurs may be of older date, as some of the lower portions of the series have not yet been clearly determined; so here we have evidence of a plant in the lowest part of the silurian formation, or even lower. By diligent search the rock in which the specimen occurs may probably be found *in sitû* in the upper part of the Laxey valley. The great resemblance, if not the identity, of the Manx with the American specimen is very remarkable, and shows the similarity of conditions then prevailing in distant parts of the globe. The specimen might have been called *Psilophytum cornutum*, if any marking on the surface of the stem had been observed, but as these appear to be absent it is proposed to call it *Psilophytum monense*. As to the nature of the water in which it grew there is no evidence from organic remains, but its characters resemble those of a fucoid more than a land plant.

THE FIGURE AND SIZE OF THE EARTH[1]

THE portion of the earth's surface bounded by the horizon which one is able to take in at one view, is but seldom a regular plane; more generally heights and depressions, mountains and valleys, alternate with each other so irregularly, that at first nothing seems farther from reality than the idea of a regular form of the earth's surface. But the more our point of view overtops the mountains which lie within the horizon, the further obviously will our range of view extend, and all the mountains and valleys which give so irregular a form to the horizon of the plain will, under this condition, become imperceptible and unimportant. Indeed, one can easily conceive that if the eye were able to comprehend at one time a much greater portion of the surface, the irregularities of the plain caused by the mountains and valleys would appear exceedingly small in comparison with the extent of surface. But such considerations must also have occurred to the ancients; for the earliest conception among the Greeks of the form of the earth's surface was that of a flat disc surrounded by the river Okeanos, into which the sun plunged nightly. The first advance was made by Thales, who said the earth must have a point of support, and imagined it was borne by the water. Anaximenes supposed that a strong dense atmosphere supported the earth. Quite another idea prevailed in India, where the earth was believed to be borne on the back of an elephant. More correct views of the figure of the earth prevailed at an earlier period in other parts of the East, in Egypt and a part of Asia. The Egyptians and Chaldeans taught at the earliest period the spherical form of the earth, and Pythagoras appears to have adopted this idea from them.

This difference of conception need not, however, be wondered at when we remember that the Greeks seldom undertook long journeys, and knew of the lands outside Greece only from fabulous narratives. It was otherwise with the people of the East, who, through their frequent and extensive travels, learned at an early period to know the positions of the stars as guides, and attained to a more correct conception of the size and form of the earth. The Chaldæans already knew the circumference of the earth so nearly that they said a good walker would take three years to walk round it.

[1] From a series of papers in *Die Natur*, by Karl Maria Friederici.

Eudoxus was the first in Greece to recognise a symmetrical curvature of the earth's surface. He had noticed on long journeys that stars which at their greatest height (culmination) stood near the horizon gradually diminished in altitude, and finally disappeared; but on his return to those regions they again gradually became visible and assumed their previous altitudes. The circumstance that these altitudes of the stars changed regularly in proportion to the length of way travelled, led him to the conclusion of a regular curvature of the earth's surface. This conclusion being accepted, a simple method was indicated for measuring the circumference of the terrestrial sphere. For suppose a star reaches at a place, A, at its maximum a height of seven degrees above the horizon, if the observer move to another place, B, lying to the north, but in the same geographical longitude as A, and measure again the highest altitude of the same star, say six degrees; then the distance of the place A from B is equal to the 360th part of the whole circumference of the earth. Let the distance between A and B be now measured, and it will be found to be sixty-nine English miles; thus the entire circumference of the earth would be $69 \times 360 =$ about 25,000 miles.

Aristotle inferred, from physical and especially hydrostatic considerations, that the earth was spherical, since, he said, the water, which formed the larger part of the upper stratum of the earth, sought, by virtue of its weight and the mobility of its molecules, to approach as near as possible to the centre of the earth, it sought to assume the lowest position, and could never be in equilibrium until all parts of its surface were equidistant from the centre of the earth, *i.e.*, formed a globular surface. This inference, near as it comes to the truth, was yet in Aristotle's time only an unproved hypothesis; the existence of a centre exerting attraction in all directions was first recognised as probable at a much later period, Newton being the first to publish the conception.

The theory according to which the earth is a spherical body, was more and more generally accepted, and was put beyond doubt when the first circumnavigation by the Portuguese Magellan (1519) became known, an example followed, at short intervals, by almost all European nations. Thus the idea so generally accepted at a very early period that the figure of the earth must be spherical, was again revived about the end of the seventeenth century. The desire to ascertain, according to the above-described methods the circumference of this circle was also cherished by the ancients, and we have accounts of measurements taken for this purpose in the earliest times, of the most important of which we give some account.

The first determination known to us of the size of the earth was made by Eratosthenes in Alexandria in the third century before Christ. He observed at the solstice (the time of its greatest northern declination) in Alexandria, the greatest altitude of the sun above the horizon, and it was known that at that time the sun stood when at its greatest altitude, in the zenith at Syene (from which we may conclude that it could be seen in a deep well). Now since the altitude of the sun above the horizon is always equal to 90° minus its distance from the zenith, he thus required only to subtract the measured height from 90°, and thus found the distance from the zenith to be the fiftieth part of the whole circumference, or 7° 12′. According to this process the distance of the two places was regarded as a fiftieth part of the earth's circumference; and as that distance, according to the accounts of travellers, was 5,000 stadia, the whole circumference of the earth was equal to 250,000 stadia. Eratosthenes altered the result to 252,000 stadia, taking for the length of a degree, 700 stadia. Without considering the great inaccuracy of his altitude measurements, there are yet too many other formidable sources of error in this estimate of the earth's circumference, to allow it any claim to much accuracy. First there was the taking for granted that both places lay on the same meridian, which was not the case, since Syene lay three degrees east from Alexandria; and second, the distance of the two places reckoned at 5,000 stadia was too great.

A second investigation was made by Posidonius in the first century before Christ, but his result was still more erroneous than that of Eratosthenes. He observed the height of one of the brightest stars (Canopus in Argo) above the horizon. It reaches, at the time of its culmination at Alexandria, an altitude equal to the forty-eighth part of the circumference, while in Rhodes it was visible just on the horizon. Hence it followed from a calculation similar to the above that Rhodes lay about $7\frac{1}{2}°$ farther north than Alexandria, and taking the distance of the two places to be 5,000 stadia, he reckoned the earth's circumference at 240,000 stadia. Here also we find the assumption that the two places lay on the same meridian, nearly $1\frac{1}{2}°$ wrong. But the chief source of error in this observation lay in ignoring the refraction of the atmosphere, which is subject to very great differences near the horizon, and makes the stars not only appear at greater altitudes than they actually have, but disturbs the places of the lower stars much more considerably than those of the upper. But we are not now in a position to be able to discover satisfactorily the extent of these sources of error in the results of Eratosthenes and Posidonius, since the stadium was of uncertain length, and we do not know in what relation it stood to our modern measures.

These are the only results worthy of notice that have reached us from these times, for then commenced the decay of science in the east, and it was only at a much later period that it flourished for a short time among the Arabs. The Kalif Al Maimon had obtained from the Greeks the writings of their philosophers, and turning his attention chiefly to mathematics and astronomy, he was incited to undertake an investigation into the mathematical figure of the earth. He formed the resolution of undertaking the measurement of a new degree, and collected for this purpose a great number of mathematicians. These selected an extensive and level tract of land, the Sinjar Desert, and made their measurements from one point, some going north, others south. The result was that the one party found a degree of the meridian to measure 56 Arabic miles, and the other $56\frac{2}{3}$. Al Maimon had the operation repeated in order to obtain a better result, but the figures obtained were the same. We have more certainty as to the unit of this measurement, the Arabic mile, than in the case of the stadium, but yet not sufficient for perfect accuracy, as appears from the following definition:—According to Alfraganus the Arabic mile contained 4,000 ells of twenty-four inches, the inch being the space covered by six barleycorns laid side by side. P. Snellius compared this measure of length with one of his own units of measure, and after numerous observations found that on an average eighty-nine barley-corns are equal to a Rhenish foot. By this proportion it is found that an Arabic mile is equal to 6472 Rhenish feet. It is usual to reckon the Rhenish foot as ·16103 of a toise, and thus the mean length of the measured degree would be 58710 toises, which is too great by 1700 toises according to recent measurements. The toise is equivalent to 6·3946 feet, or 1·949040 metre.

We have mentioned already that from the decline of science we had no other than this Arabic measurement to produce, and we may further add that the most boundless ignorance, particularly with reference to natural science, reigned supreme, especially among the European nations. But it was not enough that this inaccurate determination of the size of the earth should stand as the only one for centuries; very soon it, and with it the knowledge of the spherical form of the earth was forgotten. It was not until the sixteenth century that a French physician, Fernel, again undertook the measurement of a degree. He made use for this purpose of a peculiar apparatus, which would certainly not lead us to hope for an accurate result, but, nevertheless, through fortunate circumstances, he came very near to the truth. He had a waggon constructed which, by means of a piece of mechanism, registered the number of turns made by its wheel. With this he set out from Paris in the direction of Amiens until he had gone a degree of latitude northwards, calculated from the number of turns of the wheel the linear measure, and obtained for this distance, which, according to his observation, was equal to a degree, 57070 toises. This result, as we shall see further on, agrees very closely with later observations, which is all the more wonderful from his finding the geographical latitude of Paris too little by 12′. But since this resulted from a constant error of his instrument, he must also have observed the latitude of the other end of the arc as too little by the same amount, and thus since in the calculation only the difference of the two observations is used, these errors are without any influence in the result. The other sources of error, which arose from the unevenness of the measured distance, and evidently must have given too great a result, he eliminated by subtracting a certain quantity from his calculation, and he did this so successfully that, as we have said, his result very closely agrees with modern measurements.

Another investigation at this period into the circumference of the earth, without the help of the stars, but simply by terrestrial measurements, deserves mention. Starting from a point as high as practicable (a mountain top or high tower, whose height was known), the observer went as nearly as possible in a straight line until he reached a distance at which the top of the mountain or tower disappeared in the horizon. The distance of this point from the mountain or tower was then measured, and from simple trigonometrical considerations it will be seen that the square of this distance divided by the height of the mountain or tower would be equal to the earth's diameter. But in this method the irregular action of terrestrial refraction is so disturbing, that the point at which the mountain-top would seem to vanish must be very uncertain, and the result as to the diameter of the earth consequently very erroneous.

All the methods hitherto referred to as in use in ancient times and in the middle ages, for obtaining a knowledge of the size and figure of the earth, are deficient in trustworthiness, partly from their defective theory, but still more from the impossibility of then carrying out those practical geodetic operations which are

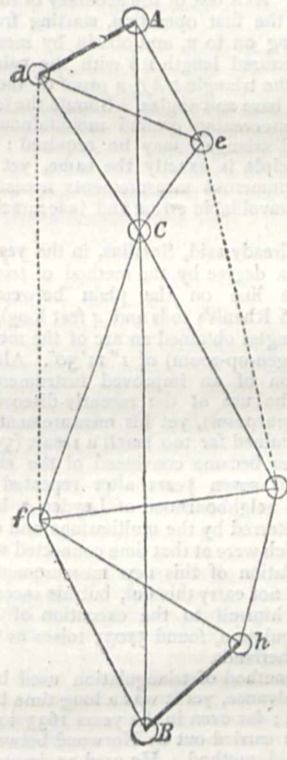


FIG. 1.

necessary for the solution of the problem with anything like accuracy. We shall see in the sequel with what wonderful accuracy it became possible to solve this important question.

The method of measuring degrees underwent, in the beginning of the seventeenth century, a fundamental reformation. Hitherto, in all such measurements, only the simplest points in the geometry of the circle had been applied, but Snellius of Leyden, making use of the properties of triangles, founded a new method for the measurement of a meridian arc, and applied it first in the year 1615—viz. the method of triangulation. His method, which has been followed ever since, possessed the invaluable practical advantage over the earlier methods, that it considerably reduced the most difficult operation in the measurement of degrees, namely, the measurement of a base line on the earth's surface. How it is possible, even in regions of very uneven surface to measure a large extent of a meridian arc with great accuracy, will be seen from the following short explanation. Suppose two places, A and B, one or more degrees of latitude distant from each other, but in the same meridian; if the unevenness of the intervening surface, from mountains and valleys, allowed of no direct measurement, one would proceed in the following manner by the method of triangulation. First setting out from A (see Fig. 1) in whatever direction the character of the ground permits, a base-line A *d* is measured with the greatest possible accuracy. At the point A, the angle *d* A *e*, and at the point *d* the angle A *d e* are observed with a circular instrument. Thus in the triangle A *d e*, the adjacent side A *d* and the two other parts of the angles being known, the triangle can be computed. Place now in the straight line connecting A and B (in the same meridian) a point C, which can be seen from the points *d* and *e*; then we may, by means of the theodolite, measure at *d* and *e* the angles A *d* C and A *e* C.[1] Subtract now from these angles the previously observed angles A *de* and A *e d*, and we have now found in the second triangle, C *de*, the angles *d* and *e*. But then, also, the side *de*, as belonging to the first triangle, is known, and thus also the second triangle, and consequently its sides C *d* and C *e* are known. But if the triangles A *c d* and A *e d* are known, so are also the triangles A *d* C and A *e* C; consequently, also, the common side A C; and thus a part of the distance is measured. To obtain the length of the other part B C, a base B *h* will be measured from B, and by operations similar to the above B C will easily be found. As a test of the accuracy of the measurements, we may connect the first operation, starting from C *ed* towards *f* and *d*, and going on to B, and obtain by means of the agreement of the measured length B *h* with the calculated length of B *h* as a side of the triangle B *hf*, a proof of the accuracy of the measurements of base and angles. Should the length A B be very great and the intervening ground mountainous, a very great number of small triangles may be required: in which case, though the principle is exactly the same, yet in practice, on account of the numerous measurements necessary under such circumstances, unavoidable errors and inaccuracies will certainly accumulate.

As we have already said, Snellius, in the year 1615, was the first to measure a degree by the method of triangulation. He measured a base line on the plain between Leyden and Sonterwonde (316 Rhenish rods and 4 feet long), and by means of connected triangles obtained an arc of the meridian (between Alkmaar and Bergen-op-zoom) of 1° 11′ 30″. Although Snellius was in possession of an improved instrument (Galileo had already taught the use of the recently-discovered telescope[2] for astronomical purposes), yet his measurements were so inaccurate that he obtained far too small a result (55011 toises for a degree). He soon became convinced of the erroneous nature of his result, and seven years after repeated the operation, measuring in the neighbourhood of Leyden a base-line in the ice. Probably deterred by the multifarious and difficult numerical operations which were at that time connected with the working out of the calculation of this new measurement by means of arithmetic, he did not carry this out, but his successor, Muschenbroek, devoting himself to the execution of this work after revising the triangulation, found 57033 toises as the length of a degree in the Netherlands.

Although the method of triangulation used by Snellius was a great step in advance, yet it was a long time before it became generally adopted; for even in the years 1633 to 1635 a degree-measurement was carried out by Norwood between London and York after the old method. He used an improved instrument (a five-foot sector) and obtained as the difference in latitude of the two places 2° 28′, and the length of a degree 57424 toises. Newton, who shortly after began the elaboration of his theory of universal gravitation, did not, at all events, know this result, since he took as the basis of his researches the earlier very inaccurate results as to the dimensions of the earth, and since he found his calculations did not correspond with them he abandoned for a time his theory.

Soon after, Picard, at the instance of the Paris Academy of Sciences, undertook anew a meridian measurement, and that not only after the improved method of Snellius (since he measured all three angles of each triangle, and computed the length of the arc by pieces), but he also gave to the measuring instruments a hitherto unattained accuracy by the addition of a micrometer apparatus.[3] He measured on the meridian of Paris an arc of 1° 22′ 55″, and finding for the latitude of that place 49° 13′, with the, as we now know, wonderfully accurate result of 57060 toises for the length of a degree. When Newton, in 1682, learned the result of Picard's measurement, he resumed his calculations in gravitation, and had the satisfaction, after thoroughly revising his work, of seeing his theory of gravitation established. A few years afterwards he gave to the world his immortal work on the mechanics of the universe. For a short time Picard's dimensions of the earth were accepted as correct and were universally made use of. But while hitherto the measurements had reference alone to the discovery of the size of the earth —for its spherical form was taken as proved—there now began a new epoch in the solution of the second part of the problem—the true figure of the earth. Influenced by the fact that the length of a degree measured at different places on the earth always gave a different result—which could not in all cases be ascribed to inaccurate measurement—Picard had already broached the idea that the earth could not be a true sphere. Soon after, Newton, in his great work, showed, on the supposition that the earth existed originally in a fluid state, that on account of the rotation round the polar axis, the supposed spherical form must be more truly that of an elliptical spheroid, the polar diameter being diminished and the equatorial diameter increased. Shortly after Huyghens was led to the same result; and while Newton by his calculations found the polar diameter to be to the equatorial as 229 to 230, Huyghens, on the basis of less general theories, found the proportion to be 577 to 578. Indeed, although differing somewhat in magnitude (Newton's proportion was then accepted as the more correct), yet, in principle, they both led to the same result, viz., that the earth is flattened at the poles, so that the length of a degree near the poles must be greater than in the neighbourhood of the equator. Moreover, Newton had shown experimentally the flattening at the pole, by rotating a soft clay sphere quickly round its axis, by which it became flattened at its poles.

To this was now added another valuable proof. The French astronomer Richer, in the prosecution of his observations at Cayenne, found to his astonishment that his pendulum, which beat seconds in Paris, vibrated too slowly in Cayenne; he had to shorten it by a line in order to make it again beat seconds accurately. On his return to Paris he had to lengthen the pendulum again by the same amount, since it now went too fast. Newton perceived that this apparently insignificant fact was really of the highest importance, for he recognised that these different rates of oscillation were due in Paris to the less, and in Cayenne to the greater, distance from the centre of the earth. Cassini's discovery of the notable flattening of the planet Jupiter was an additional proof of the truth of Newton's theory. Yet it was not until the middle of last century that Newton's theory was generally accepted as an irrefragable truth.

(*To be continued.*)

[1] There is no necessity for the point C being taken in a line between A and B, nor any advantage even if it could be done. The angles need not be measured in the way here laid down.

[2] This remark seems to imply that Snellius used a telescope in measuring angles. The application of the telescope to circular instruments was a step taken by Picard.

[3] Picard adapted to his measuring instrument a telescope with cross-wires in its focus; this appears to be the only "micrometer apparatus."

THE VARIOUS METHODS OF DETERMINING THE VELOCITY OF SOUND

THE propagation of sound is a question with many bearings in the province of physics, and the researches of physicists in relation to it, though numerous, have left some points still under discussion. It is useful in the view of further inquiry to be furnished with a historical survey of what has been already done, and this is the object of a recent memoir by Dr. H. Benno-Mecklenburg, published in Berlin (a *résumé* of which to the following effect appears in the May number of the *Journal de Physique*).

The author has adopted the following classification of the methods that have been employed for measuring the velocity of sound:—

I. Methods requiring the measurement of a time and a course traversed.

1. Direct measurement of the velocity; the most ancient measurements of this kind were executed by P. Mersenne in 1657, by the Academicians of Florence in 1660,[1] by Walker[2] (in England), in 1698; by Cassini and Huyghens (in France), &c.

2. Method of coincidences, indicated by Bosscha,[3] and employed by Koenig.[4]

[1] Newton, "Philosophia Naturalis Principia Mathematicæ," II., Prop. XLVIII.-L.

[2] Laplace, "Mécanique Céleste," t. v. livre xii. p. 115.

[3] Tentamina, "Exper. Academ. del Cimento," 1738, xi. p. 116.

[4] *Philosophical Transactions*, 1698.

3. Apparatus of Neumann[1] and Le Roux.[2]

II. Estimation of the velocity of sound by the number of vibrations and the wave-length of musical sounds.

A. Direct methods:—

1. Method of Bernouilli, with sonorous tubes.
2. Method of Chladni,[3] with rods.
3. Method of Kundt.
4. Methods of Stefan[4] and Warburg.[5]

B. Methods based on the interference of sonorous waves:—

1. Method of Savart.[6]
2. Method of measurement of the wave-length with Quincke's interference tubes.[7]
3. Method of Zach.[8]
4. Method of beats.

The way in which the velocity of sound is affected by certain circumstances, especially intensity and pitch, requires further elucidation. Up till recent times it was believed, in accordance with the earlier observations and the theoretical formulæ of Newton and Laplace, that sound is propagated with a uniform velocity in the same medium, the temperature remaining constant; that the velocity of sound in air at zero, *e.g.*, is an invariable quantity. After an observation by Parry related by Sir James Ross, that the sound of a cannon was always heard sooner than the word of command to fire, Schröder van der Kolck was led by theory to a formula giving the velocity of sound in a gas as a function of the relation of the two specific heats and the degree of compression of the medium. This velocity would be greater the more intense and grave the sound, and would diminish with the distance traversed.

Regnault set himself to determine rigorously the ratio of the two specific heats of gases, with a view to deducing the mechanical equivalent of heat. He remarked that Newton and Laplace had assumed, in their formulæ, that the gases were perfect, *i.e.* (1), that they followed Mariotte's law exactly; (2) that their elasticity was not altered by surrounding bodies; and (3) that gas opposes no inertia to the transmission of sound-waves. Accordingly the propagation of sound was supposed the same whatever the intensity. Regnault's more complete formula indicated that the velocity is greater the greater the intensity of the wave.

Experiment proved that the intensity of the wave diminishes in a tube more rapidly the smaller the section. The wave is weakened by the reaction of the elastic walls of the tube, causing a considerable loss of *vis viva*; and the diminution of intensity, according to Regnault's formula, should result in diminution of velocity, which diminution must be more rapid the narrower the tube. This was confirmed by experiment.

As regards experiments with the human voice and wind-instruments, the following are the principal observations of Regnault; acute sounds are propagated with much less facility than grave sounds; in very wide pipes, it is necessary to sing with a baritone voice in order to be well heard; the fundamental sound is heard before its harmonics, which succeed in order of pitch, and the timbre is thus altered. The velocity was found independent of pressure, as indicated by the formulæ. Lastly, with different gases, the velocities are inversely proportional to the square roots of the densities.

In connection with the foregoing, it is interesting to compare the results that have been obtained by Kundt.[9] The idea of his method was suggested by Chladni's figures. A tube of glass is used about 2 m. long, containing a certain quantity of lycopodium powder (distributed as regularly as possible), and closed at the two ends. You rub the tube longitudinally, so as to produce a sound. The powder is then seen to accumulate at the nodes of vibration, so that the sonorous waves of the gas are, in a way, rendered visible. The distance from one node to the next being half a wave length, suppose that we have twelve in the tube; the length of the tube vibrating transversely, will be the half of a wave-length in the *glass*. Under such conditions, then, the length of half a wave in the glass is sixteen times the length of half a wave in the air. It will follow that the velocity of sound in the glass is sixteen times that in air. Other gases may be used in the tube, and the velocity of sound similarly found in them.

By a simple modification of the apparatus, this method gives the velocity of sound in a large number of solid bodies, and the results agree pretty closely with those found by different methods.

But Kundt's method does not give sufficient precision in respect to the delicate questions investigated by Regnault. The wave-lengths measured never go beyond about 45 mm., making the 0·0001386 part of the course traversed by sound in a second; hence an error of 0·1 mm. made in the measurement of a wave-length would lead to an error of $\frac{11}{15}$ m. in the result sought. With this reserve, Kundt's results may be here noted.

1. The length of sonorous waves, and consequently the velocity of sound, diminishes proportionally to the diameter of the tube, when this is less than a quarter of the length of undulation.
2. In narrow tubes a high sound is transmitted more rapidly than a grave one, and the diminution of the velocity of sound is in inverse ratio to the wave-length.
3. The velocity of sound is independent of the pressure in a wide tube, but increases with it in a narrow one.

It will be seen that these latter results are in contradiction with those found by Regnault.

It may be generally affirmed that every influence which tends to increase the *vis viva* of the molecules of the sonorous medium has an accelerating action on the velocity of sound, and every influence tending to diminish the *vis viva* diminishes also the velocity.

The causes affecting the velocity of sound are (it is shown) various. *In an indefinite medium* they are:—1. The temperature of the medium; 2. The quantity of foreign substances found in it, *e.g.*, water-vapour; 3. The pitch of the sound; 4. The direction and force of the wind; 5. In solid bodies, the direction of the sound in relation to the molecular structure.

In sonorous tubes:—

6. The diameter; 7. The curvature; 8. The rugosity of the interior surface; 9. The thickness of the walls.

The action of the following additional causes is still disputed:—

1. The intensity of the sound; 2. The length of course traversed; 3. The substance forming the tubes.

There is complete disagreement between Regnault, Schröder, Kundt, and Seebeck, as regards the influence of the pitch of the sound. Regnault affirmed merely that an acute sound is transmitted more easily, but not more rapidly, than a grave sound; Schröder finds that the velocity diminishes as the acuteness increases; Kundt and Seebeck reach the contrary result. Fresh experiments are required to settle this important question.

[1] *Pogg. Ann.*, t. xcii. p. 485.
[2] *Comptes Rendus*, t. lv. p. 609.
[3] *Pogg. Ann.*, t. cxxviii. p. 307.
[4] *Comptes Rendus*, t. lv. p. 662.
[5] Chladni's "Acoustics."
[6] *Sitzungsberichte der Wiener Akademie*, t. lvii. pp. 197 and 708.
[7] *Pogg. Ann.*, t. cxxxvi. p. 285.
[8] *Comptes Rendus*, t. vii. p. 1068.
[9] *Pogg. Ann.* t. v. p. 4?6.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

A NEW supplemental charter having been granted to the University of London a few months since, on the joint application of the Senate and of Convocation, empowering the Senate to admit women to graduate in its several faculties (Arts, Science, Law, Medicine, and Music), on such conditions as the Senate, with the concurrence of the Home Secretary, should deem expedient, the Senate lost no time in passing a resolution which made all the existing regulations, relating not only to graduation, but also to the various honours and rewards granted at the several examinations open to female as well as to male candidates. This resolution having been now approved by the Home Secretary, female candidates will be admitted forthwith to the matriculation examination; and all such as have already passed the general examination for women will be considered as having matriculated, and will be admissible (after the required interval) to the first degree examination in either of the faculties. Further, with a view to the special encouragement of female candidates desiring to go through a regular academical course, the trustees of the Gilchrist Educational Trust have instituted two exhibitions, one of 30*l.*, the other of 20*l.*, per annum, tenable for two years, to the female candidates who pass highest in the honours division at the matriculation examination; and two exhibitions, one of 40*l.*, the other of 30*l.*, per annum, tenable for two years, to the female candidates who pass highest at the first B.A. examination (provided that they obtain in the first case two-thirds, and in the second three-fifths, of the total number of marks), to assist them in pursuing their studies at some collegiate institution approved by the trustees; with the further reward of a gold medal of the value of 20*l.* (or of a book-prize of the same value) to the female candidate who passes highest at the second B.A. examination, if she obtains not less than two-thirds of the total number of marks. These rewards are quite independent of those granted by the University, and may be held in conjunction with them. Further particulars may be obtained by application to the Registrar of the University, London, W.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 7, 1878.—Theory and experiment having given different results for the heat-conduction of certain (polyatomic) gases, Prof. Wüllner supposed the reason to be that the values were not comparable, because they related to different temperatures. He shows from experiment that the ratio of the two specific heats varies with the temperature. For those gases whose specific heat at constant pressure does not vary with the temperature, the variation is of about the same order as the divergence of gases from Mariotte's law. For gases, whose specific heat varies with the temperature, the ratio of the specific heats varies in a greater degree, and approximately so that the difference of the specific heats at 0° and 100° is constant. Herr Wüllner finds here an explanation of the discrepancy.—In a lengthy paper Herr Hittorf vindicates the affirmation that "electrolytes are salts," in reply to Dr. Bleekrode's criticism. We note, also, papers on the energy of reciprocal action, by Herr W. Weber, and on the law of storms, by Herr Schröder.

No. 8.—This number opens with a paper by Herr Herwig, on the amount of electricity required for full charge of a condenser platina water-cell, and on the distance of the molecules in liquid water. The upper limit he deduces for the latter is 0·186 millionth mm.; which agrees well with other determinations, Lorenz 0·1 millionth mm., Thomson (for lower limit) 0·05. He finds in the result a confirmation of the hypothesis of rotatable electrolytic molecules.—In a paper on the wandering of ions, M. Kirmis shows that the amount of transference of copper from the solution of its sulphate salt increases with decreasing concentration.—Investigating the history of the invention of the pendulum clock Herr Gerland considers that Bürgi and Treffler have not the least claim to this merit. It belongs to Galileo and Huyghens, who made the discovery independently. As the former, however, came on it fifteen years earlier, the pendulum clock is properly his work.—Herr Auerbach endeavours to show that Grossmann's vowel theory applies not to actual vowels, but to typical ideal clangs, and when the changes thus rendered necessary are introduced into it, it affords, if not incorrect results, nothing new as against Helmholtz's theory.—Herr Bauer has a paper on summation tones as difference and beat-tones from the over-tones of the primary tones; and Herren Nilson and Pettersson write on the production and valence of beryllium.

Journal de Physique, August, 1878.—In this number M. Bouty explains the construction and use of electric diagrams, for representing as completely as possible all the peculiarities of an electric field.—Some curious experiments with the electric tourniquet are described by M. Bichat.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 9.—M. Fizeau, president, in the chair.—The following papers were read:—On some phenomena of a vaso-motor action observed in the course of researches on the physiology of the excito-secretive nerves, by M. A. Vulpian.—On some new effects produced by the telephone, by M. du Moncel.—On the new palæozoic group of Dolerophylleæ, by M. G. de Saporta.—On a new gyroscopic apparatus, by M. Gruey.—On the accumulation of magnetism on the summit of hemispheric poles, by M. L. Romain.—On the waves of the high sea, by M. Ch. Antoine.—Some notes, by MM. Vasseur, Lassalle, and Cameron, regarding aerial navigation.—An additional paper by M. Giraud respecting the treatment of cholera.—A note by M. F. Bettelhauser respecting the various means employed for the destruction of phylloxera.—Prof. Asa Gray, who has been nominated a correspondent of the Botanical Section, presented the first part of his "Synoptic Flora of North America."—Rectification of the position previously assigned to the new planet discovered during the eclipse of the sun on July 29, by Prof. J. Watson, and note on the observation of a second star seen under the same circumstances.—On a new method to decompose numbers into square binary sums and its application to indetermined analysis, by M. E. de Jonquières.—On the depression which, at the surface of a horizontal elastic and isotropous ground, is produced by a weight deposited thereon, and on the distribution of this weight between its various points of support, by M. J. Boussinesq.—On the variations of intensity which take place in a current if the pressure between the two contacts, which complete the circuit is modified, by M. Treve.—On the application of the telephone to the determination of the magnetic meridian, by M. H. de Parville.—On the constitution of the inactive glucose of crude cane sugar and molasses, by M. U. Gayon.—Comparison between the *Balaena* (*Macleayius*) *australiensis*, of the Paris Museum, and the *Balaena biscayensis*, of Naples University, by M. Fr. Gasco.—On the reproduction of the *Hydra*, by M. Korotneff.—On the comparative structure of *Lepidodendron* and *Sigillaria*, by M. B. Renault.

VIENNA

Imperial Academy of Sciences, July 18.—Critical researches on the species of the natural family of the stags (Cervi), (third part), by Dr. Fitzinger.—Influence of temperature on the galvanic conductivity of liquids, by Drs. Exner and Goldschmiedt.—On some new or imperfectly-known fish-species, by Dr. Steindachner.—On the Orthoptera of Istria, by Dr. Kraus.—On new Cymothoides, by Herr Kölbel.—On the form of spark-waves, by Prof. Mach and Herr Weltrubsky.—The origin of tubes in the Nostoc-colonies in Blasia, by Herr Waldner.—Influence of the density and the temperature on the spectra of vapours and gases, by Herr Ciamician.—Action of chloroform and ether on respiration and circulation of the blood, by Dr. Knoll.—On Roussin's binitro-sulphuret of iron, by Herr Demel.—On a new method of quantitative investigation of gold and silver alloys, by Herr von Jüptner.—On the spinal ganglia and cord of Petromyzon, by Herr Freud.—Rocks from Greece, by Herr Becke.—On nitrocuminol and its derivatives, by Prof. Lippmann and Herr Strecker.—On compounds of nickel and cobalt chloride with tar bases, by Prof. Lippmann and Herr Vortmann.—On the Malabrian kinogumi, and a new substance got from it, kinoïn, by Herr Etti.—On Borneo camphor, by Herr Kachler.—On cinchonidin, by Herren Skraup and Vortmann.—Action of water on the haloid compounds of alcohol radicals, by Herr Niederist.—On the geological formation of the western part of Central Greece, by Prof. Neumayr.—On the geological formation of the island Eubœa, by Dr. Teller.

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