THURSDAY, OCTOBER 23, 1884

FIELD AND GARDEN CROPS

Diseases of Field and Garden Crops. By Worthington G. Smith, F.L.S. (London: Macmillan and Co., 1884.)

THE fact that a handbook of the diseases of crops has been written would not seem to other than botanists and agriculturists to be anything specially noteworthy. But in the British Empire, where plant economics is certainly better understood and its lessons more eagerly and thoroughly applied than in any other community, it is both true and surprising that no guide to the study of plant diseases and their prevention—at least none worthy of the name—has until now appeared. Nothing more admirable than the papers on vegetable pathology contributed by the Rev. Mr. Berkeley to the pages of the *Gardeners' Chronicle*, and the many writings of this and other authors scattered throughout our serial scientific literature, can, within their range and for their time, be shown elsewhere. But of recent years remarkable advances have been made, especially in Germany, in the study of the ætiology of plant diseases, and an excellent and comprehensive handbook was prepared a few years ago by Prof. Frank. Without doubt this author has gone as far as the state of science permitted him, but nevertheless a serious attempt to deal with vegetable pathology has yet to be made, and the attempt must be preceded by a great amount of laborious research. The activity shown in the investigation of parasitic diseases leaves little to be desired, but the many other ailments that the plant is subject to are but little regarded. That injuries are done by defective nutrition, by frost, and such like causes, is doubtless well recognised, but beyond this recognition there has not been very much inquiry into the matter. It is as if we were to be content with classifying the diseases of man into those due to the prevalence of east winds and the like.

While pathology is in this condition our therapeutical resources must continue scanty. Much may be hoped however from such researches in plant nutrition as those of Dr. Gilbert and Sir John Lawes. The means in our power of coping with the attacks of insects and of fungi are, it must be confessed, not very effective. There is doubtless something exhilarating in the wholesale destruction of insect pests by means of a judicious mixture of soap-suds and petroleum (applied on occasion by a fire-engine), and the heroic slaughter of the enemy may spur on the administrator to further and greater deeds, but except for very "local application" even this method will hardly lead to generally useful results. More—much more—is to be hoped from the encouragement of insectivorous birds, as recommended by entomologists. In fungal diseases our chief hope lies in "stamping out" either by means of the interception of a generation (where possible) on a comparatively worthless host, or by rigorous destruction of infected crops. It is true cases occur where timely amputation may save the remainder, and a method of cultivation (of potatoes) is under trial, the aim of which is to check the disease in each case at a certain stage of its progress—but the result will be seen. The introduction of new and "disease-resisting" races opens up also a means of evading fungal diseases.

Mr. Worthington Smith in the introductory chapter of his book laments that "there are no special teachers of vegetable pathology in this country, and the few men who have made the subject more or less a specialty, have not the time or opportunity for extensive or continued experiment and research." As one of those who have given much time and attention to this subject, Mr. Smith has here endeavoured to make up in some measure for this want by supplying us with a treatise on the diseases of crops, selecting such as are of the first economic importance, describing their phenomena in simple language, and considering the best means of preventing attack. With the exception of the attacks of Nematodes, he has confined himself to vegetable parasites, and of these he has supplied copious illustrations faithfully recording his views of the structure and the phases passed through by such organisms. The advice given throughout is cautious and to the point; the book is in very handy form, and within the reach of all in point of price. As such, then, it must be considered a decided gain to the farmer, the gardener, and the author's fellow-workers. Many of the last-named will regard with regret the fact that the author has not seen his way to accepting the proofs of so well-established a fact as the heterœcism of the *Uredineæ*. Mr. Smith devotes a chapter to the consideration of the subject, in which he attempts to combat the irrefragable evidence of the truth of this fact furnished us by experiment. Such objections, to give but one example, as that to the different periods occupied by the cultivation-experiments of different observers are not only of no account, but Mr. Smith must surely know from his own experience that the germination and further growth of spores as well as seeds vary exceedingly in different circumstances even under the same observer's hands. But it would be beyond the scope of this review were I to enter upon any defence of the existence of heterœcism in the Uredineæ. What is more particularly to be noticed in this section of the book is a theory of the hereditary nature of parasitic diseases. At p. 197 the author says:—

"We have shown that plants invaded by *Puccinia* and *Æcidium* carry an hereditary disease by which they are saturated, and that the disease is capable of reaching the seeds and reappearing in the youngest seedlings. Now, if plants thus suffering from hereditary disease, and having the latent germs of disease in every part of their organisation, are experimented upon in an unnatural way, have spores of fungi placed near their organs of transpiration, whose germ-threads can pierce the epidermis or enter and choke the stomata and so reach their intercellular spaces, is it not likely that this inoculating process may start into activity the latent germs of disease?"

This is illustrated by the "instance of a person constitutionally subject to phthisis (consumption): give that person a cold and phthisis appears; but the same cold will give rise to rheumatic fever with a second constitution, and scrofula with a third, according to the tendency of the individuals to these disorders." Since Mr. Smith considers the heterœcism of the *Uredineæ* as not proven in spite of the nature and the amount of the evidence, one cannot help being profoundly astonished at the ease with which he, even their own author, accepts such startling speculations concerning the hereditary nature of the parasitic diseases of plants.

In the matter of the potato disease, Mr. Smith gives a history of the whole subject, and a full description of the oospores, which he claims to be those of the *Phytophthora*. At p. 340 there is a sentence of some interest in view of the above-mentioned theory.

"It is quite possible, then, that just as every atom of a mycelial thread of this fungus (potato fungus) will continue its growth to a perfect form, so every atom of a broken-up flagellum—perfectly invisible to the eyes even when the highest powers of the microscope are used—may be capable of carrying the poison and at length reproducing the perfect form of the fungus in the potato plant."

Everything is possible, but some things are undoubtedly highly improbable, and chief among these are those which we have not the slightest grounds for supposing probable. Such is the case with this speculation since (to take the flagellum only) in the first place it is not by any means certain, as the author indeed points out in the same paragraph, that a flagellum breaks up at all, and in the second it is quite unwarrantable on any known basis of fact to suppose that its fragments are endowed with any reproductive function.

Apart from such speculations, I venture to think that Mr. Smith has rendered the study of vegetable parasites a signal service in the publication of this book. Its practical uses to the farmer and the gardener are apparent, and to the student of the subject the advantage is no less, even in those cases where the author differs from the great majority of his fellow-workers, since "the case for the opposition" is as well and as strongly stated as the materials permit. The book is of practical value in this country, and it is, moreover, one which no intelligent agriculturist can afford to dispense with in these times, when farming is engaged in a struggle of such severity at so many points. GEORGE MURRAY

OUR BOOK SHELF

How to Foretell the Weather with the Pocket Spectroscope. By F. W. Cory. (London: Chatto and Windus. 1884.)

IT is of little use putting any instrument, however simple it may look, into a student's hands, if he is not previously taught how to use it. This needful information is supplied by the handy little book now before us, showing what can be done with a direct-vision spectroscope only some 3⅜ inches long.

The book commences by describing two pocket spectroscopes now in use: the "rainband spectroscope," and a newer and somewhat larger instrument, "Grace's spectroscope," which, however, is still small enough for the pocket, being only 5⅝ inches long when closed, and which has the advantage of giving a larger spectrum. Here, however, there is a most important omission, for the adaptation of a lens to focus the image of a cloud or a part of the horizon on the slit is not referred to. Instruments thus armed are far better than those of the ordinary construction for meteorological purposes, and, as made by Hilger, they are not appreciably larger. We are next told how to use the spectroscope, and a map is given (Plate 1), showing the positions of some of the lines which the student should learn to recognise in the spectrum of the sun, in order to see at once if the rainband is present or not.

On another page we find the principal rainband itself (Plate 2), which is instructive as showing the student what to look for; but in the construction of this map a larger spectroscope, of two prisms, has been employed, so that if the student in looking for the rainband uses his pocket spectroscope, he will be somewhat disappointed. It would have been more complete if a drawing of the rainband, as seen with Grace's spectroscope, could have been given side by side with Plate 2, which shows so much of the detail.

The book concludes with letters, reprinted from the *Times*, from the Astronomer-Royal for Scotland and others, showing the value of the spectroscope for meteorological purposes.

We think no one can lay down this little volume without feeling this opinion confirmed, and that in the pocket spectroscope we possess an invaluable instrument with which to forecast the state of the weather. B.

Celestial Motion: A Handy Book of Astronomy. By W. T. Lynn. (London: Stanford, 1884.)

MR. LYNN'S long training at the Royal Observatory has eminently qualified him to write this little book. It is in no sense a school-book, but all the same it contains a most useful introduction to those parts of the science of astronomy of which it treats. These are the earth, sun, and moon; the planets arranged in three groups; comets, meteoroids, and the fixed stars. There is added a very painstaking and concise history of astronomical discovery, the only blot in which is an ineffective reference to spectrum analysis at the end.

The First Six Books of the Elements of Euclid, and Props. i.—xxi. of Book xi., and an Appendix on the Cylinder, Sphere, Cone, &c. With copious Annotations and numerous Exercises. By John Casey, LL.D., F.R.S. (Dublin: Hodges, Figgis, and Co., 1884.)

THIS is the second edition of a work which so accomplished a geometer as Prof. Henrici (vol. xxix. p. 453) has pronounced in these columns to be in many respects an "excellent" book. As the first edition contained 254 pages, and this one reaches 312 pages, it is manifest that the work has grown—and with its growth we find that it has acquired an accession of strength. We will indicate in what directions it has increased. First and foremost is the addition of the propositions of Euclid's Eleventh Book, which are generally read by junior students, and an appendix (well suited for candidates for the London Intermediate Examination) on the properties of the prism, pyramids, cylinder, sphere, and cone. There is also now given an explanation of the ratio of incommensurable quantities, and a still greater number, than in the first edition, of alternative proofs. Further, we can testify, by a careful perusal of the text, that the work has been "thoroughly revised as well as greatly enlarged." One feature we note, that whereas in the first edition the *syllabus* of the Association for the Improvement of Geometrical Teaching was often referred to by quotation, in this edition the name occurs but once or twice. There are reasons for most actions—we presume there are for this course of action.

We are glad to note that Dr. Casey makes frequent use of the term *right* line; the absence of the word "right" is liable to lead young boys astray: we should also prefer in one or two instances the term "circumference" (the line) to the term "circle."

Numerous easily rectified clerical mistakes occur, and we could wish that the author had uniformly written *AB* for a line drawn from *A* to *B* instead of apparently writing the letters haphazard. The terms *area* and *perimeter* are employed without definition; a work by Prof. Townsend (p. 142) is referred to without giving exact reference; and an examination question (p. 173) involves an acquaintance with Gauss's discoveries in regular polygons without the information having been given to the student. The proofs of i. 9 and iii. 35 appear to us to admit of improvement, the first by the familiar addition of "on side remote," &c., and the latter might advantageously be curtailed. These are small faults in a work of such extent, and we instance them to show how little we find not to our liking in an admirable text-book. We notice that Dr. Casey has adopted the convenient terms "circum-circle," "circum-centre," &c., first introduced, we believe, by W. H. H. H. in these columns. He also calls a certain well-known locus by the name of "Simson's line," following the practice now usually adopted by geometers in this country, we do not know on what authority; that well-informed writer in the *history* of the subject, Mr. J. S. Mackay, states in his edition of Euclid, recently reviewed in these columns, that he had not met with the property in Simson's writings.

Prof. Henrici in his article on "The Axioms of Geometry" (NATURE, *l.c.*) does not approve of Dr. Casey's treatment of the Fifth Book (the Algebraic), and criticises adversely Hamilton's quaternion proof of Euclid i. 32, given by our author in an appendix (cf. also NATURE, vol. xxix. p. 573). Dr. Casey prints the article as in the first edition, and takes no notice of the criticisms we refer to. A very large and well-selected collection of exercises (upwards of 800 we think), with the addition (now) of numerous examination questions, complete a work every way worthy of the reputation of the great Irish geometer.

LETTERS TO THE EDITOR

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

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

The Sky-Glows

ON reading Prof. Herschel's letter in NATURE for October 2 (p. 536), in which he so vividly describes the sunset of Sept. 20, I was so forcibly reminded by its similarity, especially with regard to the "diverging beams," to one which I lately witnessed during an excursion to the White Mountains (New Hampshire), that I send you a short account of it. It occurred on the evening of September 9 while we were staying at Twin Mount House, at a short distance from which is an elevated wooden erection, commanding splendid views of the neighbourhood. We had been watching the shadows creeping over the hills, the evening light reflected on a bend in the river below, had seen the sun go down behind the soft gray outlines of Mount Agassiz, and revelled in the glorious tints, such as Prof. Herschel describes, when, on returning to the hotel and stepping out on the balcony to take a last look, we saw, from the point where the sun had lately disappeared and where the fiery glow still lingered, these remarkable "diverging rays," so distinct in their character and so sombre in their dark (though slightly greenish) shadow-like hue—there were not many of them—that I involuntarily exclaimed that I had never seen anything like them before, and that surely the climate must have something to do with their striking appearance and unusual definition. I may mention that the day-glow was also conspicuous at times on that continent, notably at Quebec on August 25 last.

Since writing the above, I find that your correspondent, Mr. J. E. Clarke (September 18, p. 488), also refers to dark bars at sunrise and sunset, and the radiating character of the latter.

Further Barton, Cirencester, October 17 E. BROWN

THAT Mr. Backhouse is right in thinking the day-glows were entirely fresh in November of last year, the following extract from my diary confirms. As ordinary meteorological phenomena are entered upon a daily chart, my note-book only refers to what is unusual. Those whom I called to notice the sky thought it quite strange. "1883, xi. 25.—SKY COLOURING at 2.45 to 3 p.m. of a pale rosy-pink tint to the blue, giving a greenish-gray cast to cirro-cumuli where it shone through. Formed circle round sun extending from about 10° to 25° or 30° away. Inside the 10° sky yellowish. Can this have anything to do with the green sun seen in India, and therefore with the Java eruptions? Have noticed once or twice of late unusual sunset-colouring *very* late. At 4.30 strange ruddy or bright red tint on brick houses in Bootham. At 5.30 the west ruddy, as from glare of fire; still signs visible of this up to six. Sunset at Greenwich at 3.58; therefore here at 3.38. Notice also various newspaper reports and also in NATURE of striking appearances after sunset, ascribed to auroras, &c." J. EDMUND CLARK

Bootham, York, October 19

Cole's Pits

IN reference to the subject of the "Cole's Pits," respecting which a notice from Mr. A. Irving appeared in NATURE for Oct. 9 (p. 560), I find that as early as 1784 these pits, or rather perhaps some of them, were investigated by the Hon. Danes Barrington. And a paper appears on the views entertained by him regarding them in *Archæologia*, vol. vii. p. 236, under the head of "An Account of Certain Remarkable Pits, or Caverns, in Berkshire." Although Mr. Barrington expresses some doubts as to his conclusions, he nevertheless leans to the opinion that they are the winter dwellings of a pre-Roman people, the entire series constituting perhaps an ancient British town. He estimates them at about 273 in number, and covering a space of about 14 acres. In depth they vary from 7 to 22 feet, and are 40 feet and upwards in diameter, the largest being not in all instances the deepest. They extend in regular series, and are placed rather closely to each other. They are referred to a period anterior to that of Stonehenge; and it is conjectured that if each pit contained five occupants the entire community would have numbered something like a population of 1400 souls. As suitable for the residence of uncivilised people stress is laid on the fact that the place is entirely of the dried sand on the rich vale of the White Horse. The dwellings are supposed to have been entered by climbing down a rude ladder or notched pole after the manner adopted by the natives of Kamchatka in reaching their underground habitations. It is remarkable as bearing on the theory that these pits are abandoned quarries, that no objects, such as pottery, indicative that they (the pits) were used as dwellings, were found by Mr. Barrington. There can be no doubt that the pits are simply the sites of shafts dug for the purpose of obtaining the underlying ironstone. Indeed, Mr. Godwin-Austen appears to have set the matter at rest many years ago; and although I am not able at the moment to state in what paper on the subject the opinion occurs, I am in possession of a note in which Mr. Godwin-Austen, with the keen perception of the skilled geologist, observes that although "the Faringdon tradition points this spot out as the site of the castle of King Cole, whose memory is preserved in a well-known fragment of popular poetry, geology can countenance no fictions except its own, and Cole's Pits are evidently the remains of the open workings for the ironstone underlying the mass of sand."

Reading, October 10 JOSEPH STEVENS

Circular Rainbow

THE circular rainbow mentioned by Mr. Marshall seems to be similar to what may be seen at the Niagara American Falls by persons who are fortunate enough to have taken the trip under a portion of that Fall at the right time. When coming out into the front of the Fall, if the sun be shining and in a favourable position, each observer is surrounded by a rainbow of which his eye is the centre, and which accompanies him while in front of the Fall like the halo of a saint of old, but larger.

Before railroad days, when travelling by coach from Bristol to Bridgwater, I once saw a complete circular rainbow resting on the vale below the Leigh Woods, just out of Bristol.

Barnstaple, October 20 W. SYMONS

P.S.—One morning, as the sun was rising over the Southern Atlantic, the sea being moderately rough, I saw each white crested wave drowned with the prismatic colours, causing a dancing play of glorious colour never to be forgotten.

THE NEW GEOLOGICAL MAP OF RUSSIA[1]

GEOLOGISTS will be glad to hear of the appearance of the first sheet of the "Geological Survey of Russia," published by the Geological Committee on the scale of 10 versts to an inch. It comprises nearly the whole of the Government of Yaroslav and the eastern parts of Tver, between 57° 0' and 57° 42' N. lat., and 43° 10' to 47° 40' E. long., corresponding thus to Sheet 56 of the General Staff Map of Russia. This region, which is watered by the Upper Volga, the Mologa, and the Sheksna, is an undulating plain, the highest points of which, close to Bejetsk, reach 700 feet above the sea-level, gently sloping east and west to a level of from 350 to 420 feet. It has been dealt with first on account of a series of geological explorations which have already been made within its limits. It was visited by Blasius, Murchison, Keyserling, and Barbot-de-Marny, and careful explorations have been undertaken during the last few years within the limits of the province of Yaroslav, under the direction of its Provincial Assembly and Statistical Committee, by MM. Schurovsky, Piktorsky, Eremeyeff, Dittmar, Kryloff, and Nikitin.

The map, which has been prepared by M. Nikitin, is very carefully printed, and will be the more welcome to European geologists as all important names and explanations are given in French, side by side with the Russian text. The colours and the explanatory letterpress are in conformity with the recommendations of the International Geological Congress. A quarto volume, in Russian, by M. Nikitin, with plates and drawings, accompanies the map, the whole being summed up in German at the end of the volume.

The first thing which strikes one on looking at the map is the very great space covered with the gray colour of the Quaternary deposits. A greenish patch of Jurassic rocks in the middle of the map, several patches of Trias on its borders, and a very small Carboniferous patch, altogether hardly cover one-third of the surface; the remainder representing the "Boulder Clay, which conceals deposits of unknown age." The thick sheet of Boulder Clay will be for a long time the stumbling-block of Russian geologists. Natural sections are found only on the banks of the greater rivers, while the valleys of the smaller ones, to their very bottom, are cut through Quaternary deposits. Even the two railways that cross the space covered by the map have been laid without excavations of any importance to the geologist; and no artificial excavations worthy of notice are to be found in the whole area.

As to the geological description which accompanies the map, it is full of interest. The Carboniferous deposits which are denuded over a very limited space in the north-west, belong to the Upper series, characterised by *Spirifer mosquensis*. They probably extend throughout the region in nearly horizontal strata gradually inclined towards the east; but they are concealed by the Variegated Marls which are the subject of so lively a controversy among Russian geologists, and which are considered by the author as belonging to the Trias, contrary to the opinion of the Kazan geologists, who consider them Permian. Although appearing on the surface only in isolated islands, these Marls probably also extend throughout the Yaroslav region; the salt-springs at least, which appear at many places, and which usually take their origin, in Russia, either in the Devonian or in the Variegated Marls, seeming to indicate a great extension of these deposits. The Jurassic formations appear now (as throughout Middle Russia) only as sporadic islands, which are remains of a widely-extended strata destroyed by denudation; the Jurassic sea, according to the author, extending at least as far north as the latitude of Tver. The Jurassic deposits, which have been, like the Variegated Marls, the subject of special monographs by M. Nikitin, are represented in the Yaroslav region; the lower ones by the Callovian and the Oxford Clay, the two chief subdivisions of the former being characterised respectively by *Cadoceras Milaschevici* and *Quenstedioceras Leachi*, and those of the latter by *Cardioceras cordatum* and *C. alternans*. The Upper Jurassic is represented by the "Volga Series," Lower and Upper, respectively characterised by *Perisphinctes virgatus*, *Oxynoticeras fulgens*, and *Olcostephanus subditus*. They are invariably covered with a sheet of sands (like the Jurassic of Central Russia), which seems to have been a littoral deposit accumulated during the retreat of the Jurassic sea.

A very interesting chapter is devoted to the Quaternary deposits of Yaroslav and Central Russia. The thick sheet of Boulder Clay which covers Central and North-West Russia, and contains erratics from Finland and Olonetz, as also from those regions which the erratics had to cross on their way from the north, has long been a puzzle to Russian geologists. Within the limits of the map, it appears with its usual characters, that is, those of a layer 8 to 10 m. thick, spread without interruption over the country—over the watersheds as well as the valleys—without any traces of stratification or even of striation by water: the thickest boulders and the finest particles appearing closely mixed together without bearing any traces of sorting by water-currents. As to the boulders, they are of all possible sizes, from a grain of quartz to masses 2 and 3 m. in diameter. While crystalline rocks and schists from Finland and Olonetz are prevalent, local boulders—Carboniferous and sometimes Jurassic—are also not absent, especially in the lower strata. The boulders have a tendency towards a disposition in ridges which run from north-west to south-east, crossing the rivers, or rising sometimes in the shape of moraines, or eskers of great size. A sheet of boulder-bearing sand, with traces of stratification, appears at many places beneath the Boulder Clay, which passes also in its upper parts into an unstratified sand with boulders.

Such being the character of these deposits, it is obvious that the theory fails which tries to explain them by floating ice, as does also Prof. Trautschold's theory of "Eluvium." The author accepts, therefore, the theory now generally adopted by geologists, and specially advocated for Germany by Berendt, Penck, and Bernhardi, and for Russia by P. Krapotkin, and considers the Russian Boulder Clay as an equivalent of the *Krosstenslera* of Sweden. Like the British Till, it is no doubt the bottom-moraine of the great ice-sheet which covered Northern Germany and Russia, without reaching the Ural Mountains, during the ice-period. This period succeeded to a relatively mild climate, when the plains of Moscow were covered with thick oak and maple forests, inhabited by the mammoth and the rhinoceros, which were compelled by the ice-sheet slowly advancing from the north-west to emigrate east and south. The Loess of Southern Russia, and the Loess-like deposits of the intermediate region, were probably contemporary with the glaciation of the north.

Another chapter is devoted to the formation of rivers in European Russia, and to the great processes of denudation in the later parts of the Quaternary period. This subject has been keenly discussed of late by Russian geologists. The author is to be congratulated on the scientific manner in which he has laid the basis for a discussion of the three important questions—as to the Variegated Marls, the Boulder Clay, and the more recent alluvial deposits—with which he has had to deal in this first fascicule of the Geological Survey of Russia.

[1] "General Geological Map of Russia." Sheet 56, Yaroslav, &c. By S. Nikitin. (*Memoirs* of the Geological Committee, vol. i. No. 2. St. Petersburg, 1884.)

EARTHQUAKES

THOSE observers who have undertaken the detailed study of a region severely injured by an earthquake are well acquainted with the difficulties that attend on such a perilous and unthankful work as examining the ruins. The necessity is soon felt for some means of accurately registering the various characters of the earth's movement. The imperfect record of the features of an earthquake afforded by broken walls, fissured roofs, and overturned objects is dependent upon a variety of causes.

1. The earthquake consists of a series of movements that do not radiate from a mathematical point, or even from the focal cavity, with perfect uniformity.

2. The group of disturbances which constitute a shock (of variable duration) may not arise from the same point, as, for instance, in the rending of a fissure in an upward direction, the first impulses would be derived from a much lower point than the last.

3. The great variation in the physical qualities of the rocks traversed, dependent upon their composition, intimate structure, and mode of arrangement. Also we may here include the irregular conformation of the surface.

4. The want of homogeneity and of regularity in the structure of houses and walls, and also the presence of door and window openings.

5. The presence of old fissures in buildings, either the result of displacement, shrinkage, or former earthquakes.

Were it possible to construct absolutely perfect instruments for registering the complex movements of an earthquake, we should be able to exclude the two important causes of error coming under the heads (4) and (5), but the others can never be removed, unless that under head (3) might be so by a complete knowledge of the subterranean geology of a district in question—a far from easy matter.

After perusing the recent paper by Prof. J. A. Ewing on "Measuring Earthquakes" (NATURE, vol. xxx. pp. 149 and 174), one might despair of ever understanding the complex tracings the author obtained. A more careful consideration of the subject would seem to help us out of the difficulty to a considerable extent in so far as theoretical reasons will permit us, and it is not till suitable seismographs have been fairly tried in other districts than the unsuitable alluvial plain of Yeddo that we shall learn whether there is any practical use in instrumental observation of earthquake movements.

In an alluvial plain like that of Yeddo, reposing as it probably does on the irregular surface of different but more elastic rocks, from which are transmitted to it the vibrations, the condition is such that a number of waves would be reflected and refracted so as to meet each other at various angles interfering with each other and producing very complex results on any pendulum instrument.

I am personally neither acquainted with the geology of the region in question nor with the type of disturbances constituting its earthquakes, yet from descriptions of the latter one would feel inclined to regard them as the tail-end movements of powerful shocks far below the surface, conditions highly favourable to complexity from reflection and refraction. Besides, the incoherent alluvium, often water-logged, is subject to a remarkable disturbance when vibrations are communicated to it from without, as may experimentally be illustrated by spreading jelly, or, better, mud, over the irregular surface of a piece of wood and tapping with a hammer.

These remarks may at first sight appear beyond the question, but we must not leave the subject without further trial. Any one who has studied the injuries resulting from destructive earthquakes such as that of 1857, described in Mallet's classical memoir, or of those of 1881 and 1883 in Ischia, cannot but be struck with the regularity of the injuries when the observer carefully excludes the large number of modifying influences, as heterogeneity in structure of buildings or the surface configuration of the point in question.

The following instruments were suggested by the study of the two great Ischian earthquakes, and with suitable modifications might be made appropriate to study small or great shocks as the case might require. The use of a pendulum as the main part of the mechanism has many objections, which have often been pointed out, and I think that future investigations will strongly confirm such opinions. Nevertheless I have given examples where the pendulum may be used, or replaced by other methods employing the same type of registering apparatus (Fig. 1). *a* is a pendulum with preferably a pear-shaped bob of great weight, which has attached to its lowest point a strong plaited thread of dentist's silk, *e*, which passes through a perforated glass plate, *d*. The hole in the glass plate is smoothly drilled of the exact size of the silk thread, so as to allow it to run easily but no more; it has its lip smoothly rounded off so that a section of the edge (see *d'*) is semicircular. The glass plate is firmly gripped by the horizontal metal plate *c*, which is rigidly fixed to the supports *b*, which in their turn are embedded in a solid masonry or rock basement. The silk thread is connected by a light wire cage, *f*, to the cylinder *g*, which slides easily up and down the fixed triangular column *h*. The cylinder *g* is connected to the writing arm lever *i*, which

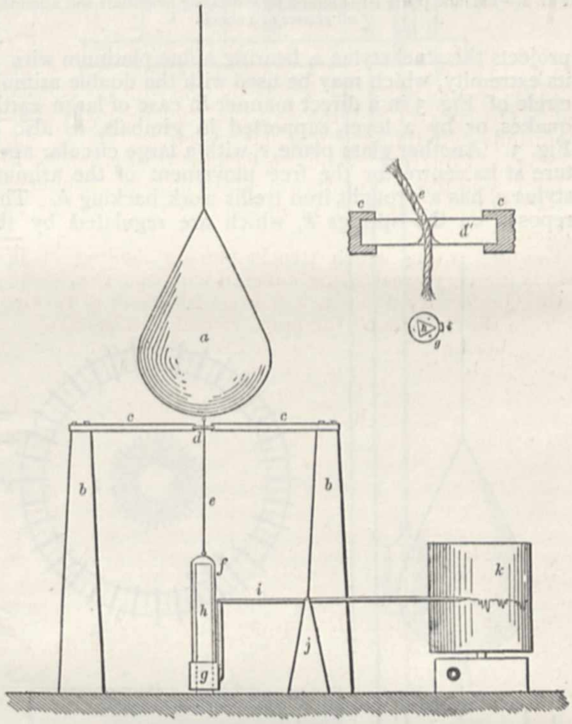


FIG. 1.—Pendulum apparatus to register amplitude of wave continuously.

may be short, and write directly on the recording drum *k*, being then a simple stylus, or, as in the figure, arranged to magnify the amplitude two or more times at choice.

When any earth-movements take place, the *relative* horizontal swings of the pendulum are converted into vertical movements of the silk thread, cylinder, and stylus, which on a time-ruled recording sheet will give accurate amplitude tracing minus the friction of the apparatus, which, if well constructed and the pendulum proportionally very heavy, may be excluded. By using a heavy pendulum with short suspension we may measure oscillations of short period, or, by using a long suspension and a delicate apparatus with greatly magnifying lever, this apparatus might be a useful tromometer, or measure of slow earth oscillations or tiltings (Fig. 2).

Three solidly-fixed cast-iron uprights, *a*, support a circular massive cast-iron plate, *b*, which has a conical aperture at its centre. Resting upon this is a circular sheet of plate-glass drilled at its centre in the same manner as the silk thread perforation in Fig. 1, as it serves a similar purpose. This glass plane must be perfectly horizontal. A circular disk of lead, *g*, is inclosed between glass planes, *d*, and rests on three perfect spheres, *f*, which should be preferably of glass or ivory. Rigidly attached at its centre on the lower side is a conical spire, *m*, whose point reaches just the level of the glass plane *c*, and has fixed to it the silk thread *n*. From the centre of the upper side

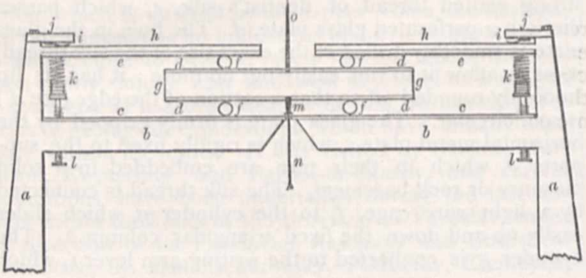


FIG. 2.—Ball and plane seismograph for indicating amplitude and azimuth in all phases of a shock.

projects the steel stylus *o*, bearing a fine platinum wire at its extremity, which may be used with the double azimuth circle of Fig. 3 in a direct manner in case of large earthquakes, or by a lever supported in gimbals, as also in Fig. 3. Another glass plane, *e*, with a large circular aperture at its centre for the free movement of the azimuth stylus *o*, has a wrought-iron trellis work backing *h*. This reposes on the springs *k*, which are regulated by the

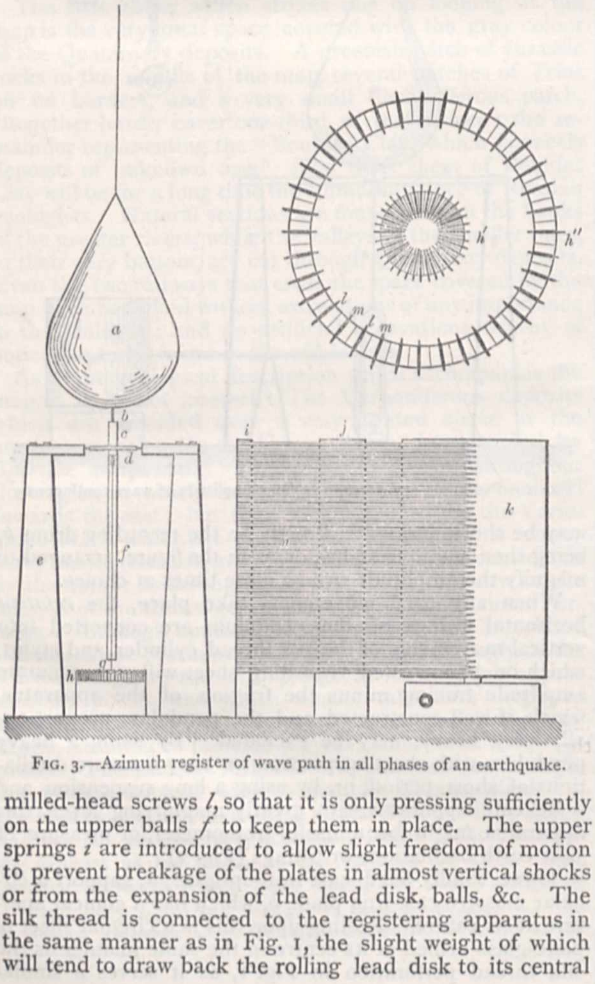


FIG. 3.—Azimuth register of wave path in all phases of an earthquake.

milled-head screws *l*, so that it is only pressing sufficiently on the upper balls *f* to keep them in place. The upper springs *i* are introduced to allow slight freedom of motion to prevent breakage of the plates in almost vertical shocks or from the expansion of the lead disk, balls, &c. The silk thread is connected to the registering apparatus in the same manner as in Fig. 1, the slight weight of which will tend to draw back the rolling lead disk to its central position, and so prevent it shuffling out of its place, and yet have almost no effect in modifying the register of the absolute wave amplitude.

In working over an earth-shaken district of small area, such as that of Ischia, an error of observation of azimuth of even a few degrees matters little in determining the exact position of the epicentre. But on the contrary, in large areas such as the Neapolitan earthquake of 1857, and to a far greater extent in widespread disturbances such as the great Lisbon catastrophe, an error of a few minutes of a degree is sufficient to produce great divergence in the orientation of the azimuth and a consequent incorrectness in the location of the epicentre. In most seismographs so far employed, especially those of Italy, no attempt has been made to divide the circle into eight divisions, so that an error of nearly 45° could occur.

Fig. 3 represents a separate apparatus, although it would probably in practice be found preferable to replace the pendulum by the rolling disk and balls as already mentioned when describing Fig. 2, except that the contact rings *h* would then be inverted. A pendulum, *a*, with a

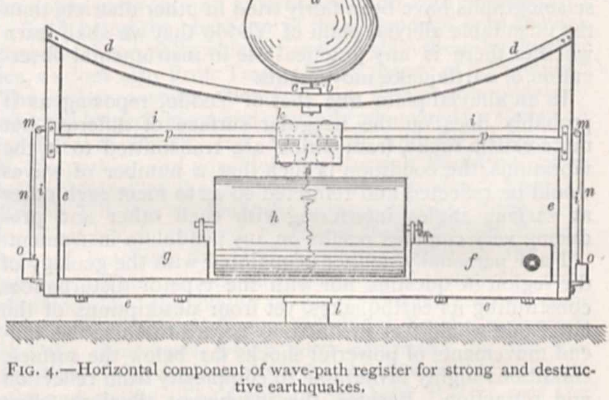


FIG. 4.—Horizontal component of wave-path register for strong and destructive earthquakes.

length of suspension suitable to circumstances of observation, carries a steel spring wire, *b*, which slides in the cylinder *c*, which, together with the light wire arm *f*, forms a universal lever moving about the fulcrum at *d*, which are gimbals. This lever should be so balanced that, if placed in a horizontal position, the part above *d* should counterpoise the part *f*. The lever carries a fine platinum wire, *g*, which, when at rest, is the centre of the two contact circles *h*, *h′*, *h″*. This part of the mechanism is in connection with one pole of a battery.

The contact circles *h* seen in detail, *h*, *h*, consist of a suitable number of brass segments, *l*, which have a V-shaped groove on their upper surface, and the edges, both inner and outer, are bevelled off. Each one is insulated from its fellow by the vulcanite plates *m*, which project a little on the inner, upper, and outer sides, and are sharpened to a knife edge.

The registering apparatus consist of a number of long soft-iron spring styles bolted to the column *i*, with their points near the revolving register cylinder *k*. A pile of electro-magnets, *j*, each of which is in connection with the two corresponding segments of the two contact circles and the battery, when the current passes, draws one soft-iron spring style towards its poles, and brings the point in contact with the cylinder *k*. The pendulum might be made to act directly on the contact circles without the magnifying lever *c f*, if thought necessary, and the breadth of the outer circle might be greater and give a correspondingly longer dash so as to distinguish those derived from the two circles.

It will be seen that the most complex movements of the pendulum or rolling disk can be accurately registered, since four contacts will be marked in each semiphase of the oscillation of the pendulum, and a fifth point can be obtained by calculation from the instrument for registering amplitude, which, together with the position of rest, will give sufficient data to obtain the loops for each semiphase throughout the disturbance.

In large earthquakes where the wave-amplitude is very great, the rolling disk and balls would require to be of very great size, which in many cases it might be impracticable to carry into execution, although the results might be of great perfection in so doing. The present instrument (Fig. 4) is intended to replace the rolling disk where that cannot be used of sufficient size.

A strong rectangular frame, *e*, carrying two strong uprights at its two extremities, is made so as to rotate with great facility around the vertical axis *l*. It supports the registering drum *h* with the clockwork arrangement *f* and a counterpoise, *g*. In practice it might be found advisable to attach these beneath the frame and so lower the centre of gravity of the whole apparatus. At a suitable distance above the drum a crossbar, *p*, is attached, which should be highly polished and square in section. The weight *j* should be made very heavy, and be allowed a very easy motion by means of four pairs of wheels, *k*, which are in contact with the crossbar *p*; these might be mounted on friction wheels (not shown in diagram). Attached on both sides of the weight are the silk threads *i i*, which traverse the upright, run over the pulley *m*, and are attached to the weights *o o*, which are only heavy enough to draw the weight *j* back to its place when it has been disturbed, that is to say, only just sufficient to overcome the friction of the wheels *k*. These weights, *o o*, are traversed by the guide wire *n* to prevent them dangling about during the swinging round of the frame.

The upper part of the frame carries two parallel bars, *d*, between which is a narrow groove to allow of the sliding of the plate *c*. They form the segment of a circle whose radius is equal to the length of the entire pendulum and its suspension. The pendulum *a* has fixed rigidly to its inferior extremity the steel axle *b*, which passes through the rectangular flat block *c*, which is prevented from slipping off by a bolt-head below, so that the flat block can rotate around the axle without falling off.

The action of the apparatus is as follows:—When an earth movement takes place the whole apparatus is brought into the azimuth of the wave-path by the oscillations of the pendulum *a* in that direction, which is affected by the block *c* sliding in the groove between the bars *d*. The pendulum should, in preference, have a short suspension, so that the period of its oscillations should be less than the wave intended to be registered by the apparatus, and should possess sufficient weight to have complete command over the frame, keeping it always in the wave-path azimuth. The weight will now appear to slide backwards and forwards on the bar *p*, registering its movements by the writing stylus, attached beneath it, on the drum *h*. The moment that *j* is moved from its central position one of the weights *o* is raised from its position of rest (these weights should preferably be hollow brass boxes into which only sufficient fine shot could be poured to overcome the friction of *j*), and rises as long as *j* continues to roll along the bar; if then the second half of the semiphase is not sufficient to bring it back to its normal position this will be done by *o*. When *j* has reached its central position, *o* will have come to rest at the base of the guide wire, and so no longer has any action, but is replaced in the second semiphase by its fellow of the opposite side. Of course the influence of the counterweights in retarding the rolling mass must be experimentally tried and taken into consideration in the calculations made from the tracings.

The principle of this instrument is the acceleration and retardation of a falling body during each semiphase of an earth-wave. Fig. 5 illustrates a means of registering such changes in the rate of a falling body so acted on, although some other person better acquainted with mechanical movements might possibly suggest some improvement.

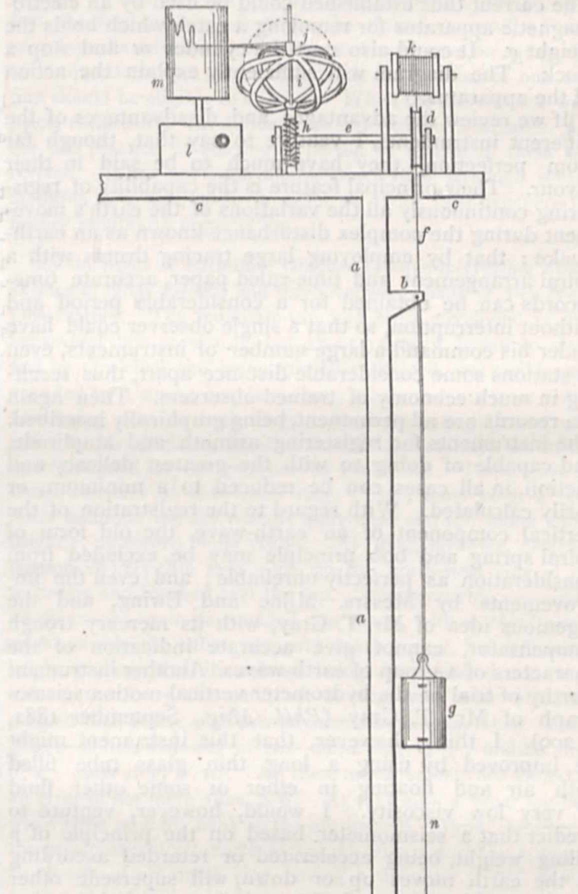


FIG. 5.—Apparatus for registering the vertical component of earth-waves during the whole of the disturbance.

A rigid vertical support of considerable length, *a*, is attached to the side of a well and is connected at its upper end to the table *c*; and by a small bracket *b* two vertical guide wires, *n*, pass through rings in the sides of the weight *g*, so far resembling Morin's apparatus illustrating the falling of bodies. Attached to the weight *g* is the silk thread *f*, which turns once or twice around the wheel *d*, and is supplied from the drum *k*. The wheel *d* is connected by the axle *e* and the continuous screw *h* to the apparatus *i*, which is a skeleton of flat steel springs, generally used to illustrate the distortion of a sphere by centrifugal motion. (I have proposed this in preference to the *ball governors* as retaining less impressed energy, which would unnecessarily complicate and even modify the results.) Sliding on the central axis of the spring sphere is a small cylinder, *j*, which is prevented from rotating by means of a ridge on its inner surface and a corresponding groove on the upright bar. This cylinder carries the writing arm and stylus, which registers on the cylinder the rising and falling of the former; *l* is the motive power of the cylinder *m*. The apparatus for detaching the falling weight *g* is not shown in the diagram, but might be of the following arrangement:—A bob suspended by a spiral spring is made to make contact with a cup of mercury, as in the old form of vertical seismometers, besides a small lever of the first order attached at one end to the bob, the other extremity being above another cup of mercury. In this way, whether the movement of the bob be either up or down, in relation to the mercury cups, contact will be either made in the first case through the lever, or in the second directly by the bob. The current thus established could be used by an electromagnetic apparatus for removing a catch which holds the weight *g*. It could also start the cylinder *m* and stop a clock. The diagram will sufficiently explain the action of the apparatus.

If we review the advantages and disadvantages of the different instruments, I venture to say that, though far from perfection, they have much to be said in their favour. Their principal feature is the capability of registering continuously all the variations of the earth's movement during the complex disturbance known as an earthquake; that by employing large tracing drums with a spiral arrangement and time-ruled paper, accurate time-records can be obtained for a considerable period and without interruption, so that a single observer could have under his command a large number of instruments, even at stations some considerable distance apart, thus resulting in much economy of trained observers. Then again the records are all permanent, being graphically inscribed. The instruments for registering azimuth and amplitude, and capable of doing so with the greatest delicacy and friction, in all cases can be reduced to a minimum, or easily calculated. With regard to the registration of the vertical component of an earth-wave, the old form of spiral spring and bob principle may be excluded from consideration as perfectly unreliable; and even the improvements by Messrs. Milne and Ewing, and the ingenious idea of Mr. T. Gray, with its mercury trough compensator, cannot give accurate indication of the characters of a group of earth-waves. Another instrument worthy of trial is the hydrometer vertical-motion seismograph of Mr. T. Gray (*Phil. Mag.*, September 1881, p. 209). I think, however, that this instrument might be improved by using a long thin glass tube filled with air and floating in ether or some other fluid of very low viscosity. I would, however, venture to predict that a seismometer based on the principle of a falling weight, being accelerated or retarded according as the earth moves up or down, will supersede other methods, although no doubt such means of registering as described in this paper may be greatly improved upon.

The instruments described in this paper are all of considerable size, but it seems impossible to get good results unless heavy weights and their attendant mechanisms are used so as to reduce friction to a minimum in the consideration of results; for it is certainly a pity to have imperfect results in consequence of limiting the size of the apparatus. One great objection to the falling weight seismometer is the necessity for a deep well, to give sufficient time to register an earthquake of ten or twenty or even more seconds' duration; yet, by giving the weight more work to do by the introduction of multiplying wheels, this might be reduced as the circumstances might demand.

These instruments and the remarks on them are the outcome of long meditation while wandering over the ruins of two great earthquakes, and although expressed without a technical knowledge of mechanical construction, I hope I have made my ideas sufficiently clear.

H. J. JOHNSTON-LAVIS

INTERNATIONAL WEIGHTS AND MEASURES

IN inviting attention to the work done at Sèvres during the past year by the Comité International des Poids et Mesures,[1] we are glad to have the opportunity of congratulating those interested in accurate measurement on the fact that this country is now to be represented on the Committee, and will thus have a voice in their discussions. This, as we have pointed out on previous occasions, appears to be required of a country so largely interested in scientific research as ours.

METRES

Description of Standard	Error in terms of the true standard metre ($I_{2(0)}$—6μ)	Mean coefficient of dilatation, 0° to t° C.
Standard I_2, which serves as the provisional standard of the Comité until the final prototype is verified ...	μ + 6·00	$10^{-9}(8594·6+1·26t)$
Standard I. for the use of the Bureau	+ 76·04	$10^{-9}(8602·9+2·09t)$
Standard II. for the use of the Bureau	+ 80·61	$10^{-9}(8569·1+2·79t)$
Standard III. for the use of the Bureau	+ 14·53	$10^{-9}(8560·0+1·63t)$
Standard XIII., belonging to French section of the Comité	+ 3·05	$10^{-9}(8540·6+2·62t)$
Bronze subdivided Standard N belonging to the Comité	+ 48·58	$10^{-9}(17483+7·07t)$
Brass Barometer-Standard T_1 belonging to Comité, constructed by Société genevoise pour la Construction d'Instruments de Physique	− 7·2	$10^{-9}(18178+7·9t)$
Brass Barometer-Standard T_2	− 31·6	$10^{-9}(18213+7·2t)$
" " T_3	− 0·5	$10^{-9}(18037+4·7t)$
Brass Barometer-Standard constructed by Messrs. Hermann and Pfister, P...	− 149·3	$10^{-9}(18821+8·4t)$
Platinum Standard for Spain originally constructed by Froment with lines traced by J. Alfonso, Secretary to Standards Commission at Madrid, E	+ 4·95	$10^{-9}(8898)$
Iron Standard of the United States Government made by Repsold, US	+ 97·8	$10^{-9}(10563)$
Standard for Office of Weights and Measures at Vienna, H_A	+ 14·1	$10^{-9}(18708+3·00t)$
Standard for Office of Weights and Measures at Vienna, A_A	− 8·9	$10^{-9}(17971+3·15t)$
Iron Standard of Société genevoise, F	− 31·4	$10^{-9}(11063)$
Brass Standard of Société genevoise, L	− 62·6	$10^{-9}(19155)$
Bimetallic Standard for French War Department, constructed by Porro—		
Brass, C	− 111·8	$10^{-9}(18699)$
Steel, A	+ 31·1	$10^{-9}(10420)$
Copper Standard for M. Tresca, Cu	+ 10·7	$10^{-9}(16334+5·82t)$
Green Glass Standard made by M. Baudin for thermometric purposes, V... ...	+ 128·2	$10^{-9}(8392+4·8t)$

[1] "Travaux et Mémoires," tome iii. 400 pages. (Paris: Gauthier-Villars, 1884.

KILOGRAMMES

		mgr.	mgr.
International kilogramme KI belonging to the Bureau ...		—	—
International kilogramme KIII belonging to the Bureau ...	KI—KIII = −0·1232±0·0026		
Kilogramme-type C belonging to the Bureau	C—KIII = +0·3217±0·0034		
Kilogramme-type S belonging to the Bureau	S—KIII = +0·4632±0·0034		
Standard kilogramme H for Spain	H—KIII = −1·8762±0·0034		
Standard kilogramme Z for Austria	Z—KIII = −1·3501±0·0034		

The present volume, like its two predecessors, is published by the Director of the Bureau under the authority of the Comité, and contains some account of the modes of comparison of the standards, with descriptions of the apparatus used, and a complete statement of the observations and of the methods of their reduction. The work of the Bureau has mainly included determinations of the lengths of certain standard metres and of the weights of certain standard kilogrammes for different Governments and authorities, as shown in the above tables.

These tables do not include the important comparisons of the British Standards with those of the Bureau, an account of which is given in a Report presented to Parliament by the Board of Trade last year, and in the Report of the Proceedings of the Committee for 1883.

The comparisons of the metres by Dr. René-Benoit, and those of the kilogrammes by M. Marek, were made in the same manner and after the same methods as those described in vols. i. and ii., to which we have previously referred.

M. Marek gives a thoughtful description of the excellent normal barometer and cathetometer in use at the Bureau, as well as of the methods of calibrating the thermometers used during the weighings. There are also illustrations of the apparatus used in ascertaining specific gravities, and of M. Stas's method for clearing the surfaces of metals by a jet of alcohol vapour, of which we regret that the demands on our space do not allow an account.

The many pages of observations and calculations which are given in this volume are clearly arranged and carefully printed. We doubt, however, whether it may be desirable to publish so much detail, particularly all the observations of the balances. Each Report of verification should evidently include all the observations, &c., from which the results have been obtained, but it would appear to be necessary only that the Government or authority directly interested should be furnished with a full detailed Report. Economy of time and money might be effected to readers and purchasers, and perhaps the objects of the Comité further advanced, by the omission in such publications of any unnecessary detail.

NOTES

THE Washington Prime Meridian Conference has adopted a resolution declaring the universal day to be the mean solar day, beginning, for all the world, at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day, and that meridian to be counted from zero up to twenty-four hours. The resolution further declares that the Conference expresses the hope that, as soon as practicable, astronomical and nautical days may be arranged everywhere to begin at mean midnight. Prof. Janssen, of France, moved that the Conference should express the hope that technical investigations to regulate and extend the application of the decimal system to the divisions of the circle and of time would be resumed, in order to permit of the extending of that application to all cases where it might present real advantages. The motion was adopted, and the Conference adjourned until Wednesday.

M. BERTRAND, the Perpetual Secretary of the Paris Academy of Sciences in the Mathematical Section has been proposed as a candidate to fill the place vacated by the death of M. Dumas in the Académie Française. His nomination is certain, and will take place without opposition. It is almost customary for the Académie Française to offer a seat to one of the secretaries of the Academy of Sciences; Delambre, Fourier, Flourens, Cuvier, and Dumas enjoyed this honour in succession. Arago was offered it several times, but obstinately refused it. He strictly adhered to the old constitution of the Institut National as created by the Directory of the First Republic, which states that the five sections constitute the several parts of a living encyclopædia established to deliberate *in common* on many different questions, and that consequently no member of one section should be eligible to another. When the Restoration took place, the Institut was divided into independent academies, and the old practice of electing a person to several of them was revived. It has not been altered since 1848, although several attempts have been made in order to recall into existence the former republican organisation.

ON the night of Saturday, October 4, some interesting observations of lunar coronas and fog-bows were made at Ben Nevis Observatory. The mountain-top had been enveloped in mist for several days previously, but about 9 p.m. it began to clear, and by 11 o'clock the moon, partially eclipsed, was visible, surrounded by a strong double corona; all the colours from red to blue being seen in both rings. Measurements of these were taken by Mr. Dickson, Interim-Superintendent, with an instrument designed for the purpose by Prof. Tait. These gave:—Outer diameter of red—outer ring, 7° 46′; inner ring, 4° 52′. After midnight the sky became quite clear and the moon shone brightly, no corona being visible. At times, however, detached portions of very thin mist came up the north-west side of the mountain and brushed over the top. Whenever this occurred a strong corona again surrounded the moon, with a *third* set of rings, outside the other two, and much fainter, but sufficiently bright to allow of all the colours being distinguished. At 1.30 a.m. on October 5 the outer set of rings was more distinctly marked than before, and measurements were again taken. These gave:—Outer diameter of red—inner ring, 4° 6′; middle ring, 6° 2′; outer ring, 8° 10′. All these measurements are subject to an error of not more than ± 6′. At 1.15 a.m. a lunar fog-bow was visible on a fog bank to the northwards. From the edge of the precipice to north-north-east of the Observatory this appeared to consist of an outer ring, having a diameter of 75°, and an inner and fainter ring, diameter 65°, the space between the rings appearing almost quite dark, as if caused by a sharply-defined break in the fog. No colours could be distinguished.

FROM the *Alta California* we learn that the Lick Trustees have just received, through the kindness of Capt. Goodall, of the firm of Goodall, Perkins, and Co., important advices from Paris in regard to the glass disk which is needed to complete the 36-inch equatorial for the Lick Observatory. It will be remembered that the contract for two disks—one of flint and the other of crown glass—which are needed for the construction of an achromatic objective, was let to the celebrated firm of Alvan Clark and Sons in 1861. There were only two firms in the world who were capable of making glass disks of such size, nearly 40 inches in diameter. The Clarks employed one of these, Messrs. E. Feil and Co. of Paris, to cast the rough disks for them. The flint disk was cast in an unexpectedly short time, but the making of the crown glass disk has proved to be a matter of great difficulty, and this alone will have delayed the making of the large objective, and thus the completion of the Lick Observatory, by several years. The Lick Trustees will have all the Observatory, excepting the large telescope and the dome to contain it, finished and ready for work during 1885. As soon as two perfect disks of crown and flint glass are on hand, the focal length of the telescope can be calculated, and the size of the great dome determined upon; and nothing can be done until this focal length is known. Nineteen trials have been made by the Messrs. Feil to cast a perfect crown disk, and a delay of more than two years has been incurred through the difficulties and risks of the operation. It appears from the letter of Capt. Goodall to Capt. Floyd, which has been referred to, that Messrs. Feil have cast two disks, which they expect to be suitable for the purpose. The Captain visited their works early in September, and they were expected to ship one of the disks to Clark and Sons early in October. There is then reason to believe that the rough disks for the large telescope will soon be in the hands of the optician. The successful working of these disks into the proper curve for a perfect object-glass is a matter of the greatest difficulty, but the extraordinary skill which the Clarks have acquired leave no doubt that within two or three years after the receipt of a perfect disk the whole 36-inch objective (the largest possible) will be finished. While the objective is making, the dome and the mounting can be constructed, so that the whole delay is and has been due to the difficulties incident to the opticians' work. The work on Mount Hamilton has progressed as far as possible under the present conditions, and it will not be long before California possesses the most perfect observatory in the world, placed in the most favourable situation which can be found.

The recent works of the United States Geological Survey, and especially the remarkable report of Capt. Dutton, have given an opportunity to Prof. Trautschold of Moscow, to draw a parallel between the geological structure of Colorado and that of European Russia, which appears in the *Bulletin* of the Moscow Society of Naturalists. In Russia, the Silurian, Devonian, Carboniferous Limestone, and Lower Permian series are marine deposits, while the Upper Permian is of fresh-water or terrestrial origin. The Trias and Lower Jurassic rocks are also continental deposits,—or seem to be so to a great extent,—while the Upper Jurassic groups are again of marine origin, as is also the Chalk, which contains only islands with land-vegetation. Three parts of the Tertiary series consist of terrestrial and fresh-water deposits, marine deposits appearing only in the south; and the Quaternary is also a continental formation. Such being, according to Prof. Trautschold, the structure of Russia, he had already concluded that in the Northern Hemisphere there was a general retreat of the sea during Palæozoic times, and a growth of continents, upon which the Carboniferous and then the Permian floras largely increased, European Russia being, during the Triassic and the first half of the Jurassic periods, a continent with nearly the same outines as now. During the second half of the Jurassic period, another subsidence of the continent, and an advance by it into the Northern Hemisphere, again took place, without reaching, however, the same level that it had had during the Palæozoic period; the sea remaining shallow. A second retreat of the water took place during the Tertiary and Quaternary periods. Similar oscillations might well explain, in Prof. Trautschold's opinion, the structure of the Grand Cañon district, where the connection between the Juras ic and Triassic is as close as in Russia.

The next ordinary general meeting of the Institution of Mechanical Engineers will be held in the large Lecture Theatre, University College, Shakespere Street, Nottingham, on November 5. The chair will be taken at 4 p.m., by the President, I. Lowthian Bell, F.R.S. The following papers will be read and discussed, as far as time will admit:—On the Mineral Wagons of South Wales, by Mr. Alfred Slater, of Gloucester; on the Application of Electro-Magnets to the working of Railway Signals and Points, by Mr. Illius A. Timmis, of London; Second Report on Friction Experiments, by Mr. Beauchamp Tower, of London.

The International Congress convened to deliberate upon the best means of preventing the spread of *Phylloxera vastatrix* was opened on Monday at Turin. Among the personages present were the Duke d'Aosta, Signor Grimaldi, Minister of Commerce, the Syndic of Turin, and the French, Greek, Spanish, Portuguese, Servian, and Roumanian Delegates to the Congress. After a short address of welcome from the Syndic of Turin, Signor Grimaldi explained the object of the Congress, and dwelt particularly upon the necessity of common legislative measures being adopted in all infected countries in such a form as not to interfere with the liberty of trade. It was, however, most requisite to raise barriers to the spread of the Phylloxera.

The last issue of the *Transact ons* of the Seismological Society of Japan (vol. vii. part 1) contains a paper by Prof. Milne on Earth Tremors, dealing successively with artificially produced tremors, natural tremors, and at some length with various instruments constructed to record these minute movements. Microseismology, by the way, appears to be the name of this new branch of science. The results which have been obtained so far do not appear to be of great importance. The motions are more law-abiding than earthquakes; but it is impossible to say yet whether their systematic study will enable us to foretell an earthquake, although from examples quoted it appears that earthquakes are frequently preceded by great microseismic activity. Nor is the cause of these constant movements understood. Among the theories on this subject mentioned by Prof. Milne is one that they may be due to slight vibratory motions produced in the soil by the bending and crackling of rocks caused by their rise upon the relief of atmospheric pressure. Rossi thinks they may be the result of an increased escape of vapour from the molten material beneath the crust of the earth consequent upon a relief of external pressure. In the same number Dr. Du Bois writes on the great earthquake of Ischia; and a catalogue of earthquakes in Tokio between July 1883 and May 1884, as observed by a Palmieri's seismograph, is also given. From the annual report of the Society we observe that the committee appointed to report on a system of earthquake observations give as their conclusion that the most important observation is that of time, and experiments are now being carried out to obtain a suitable clock for this purpose. The next number is to contain an important paper by Prof. Milne giving a detailed account, with a series of maps, of 387 earthquakes recently felt in Northern Japan.

Mr. Spence Paterson, H.B.M. Consul at Reykjavik, writes to the *Standard* that on September 9 he visited Cape Reykjanes, the south-west point of Iceland, in order to observe the volcanic island which recently appeared off that Cape. It was first seen by the light-keeper at Reykjanes on July 29, and had then the shape of an irregular truncated cone, with a slight hollow on the top and a projecting shoulder on the north side. No earthquakes or other volcanic manifestations accompanied its appearance, but on August 5 a series of severe shocks occurred, which split the walls of the lighthouse and damaged the lamps. For several days rain and fog obscured the island; when next seen, its shape had altered; part of the south side had fallen down into the sea, forming two little mounds, and leaving a steep, almost perpendicular face on the south. The height of the island is about two-thirds of its length. It lies about west-south-west of Reykjanes. Two officers of a French war-vessel, who recently visited Reykjanes, estimate its distance from the coast at nine or ten miles, but Mr. Paterson believes it to be considerably greater. When first seen, the upper part of the island was perfectly black, but it has now begun to whiten, owing to the droppings of the myriads of sea-fowl which frequent the adjacent coast and neighbouring islands, and seem already to have taken possession of the new land. The neighbourhood of Reykjanes is noted for volcanic manifestations—islands have from time to time risen and sunk there, and only a couple of years ago a violent eruption occurred near the spot where the new island lies; columns of smoke and steam rose out of the sea, and large quantities of pumice were thrown up and floated ashore on the neighbouring coast.

It is stated that in consequence of the immense success obtained by the opening of the Arlberg Tunnel, France has confidentially sounded the Swiss Federal Council as to piercing the Alps at the Simplon.

A fatal gas explosion took place in Paris four months ago near the Porte St. Denis, under circumstances quite similar to the accident which took place in Bermondsey last week. Since that time the Prefet de la Seine has appointed a Commission to determine the best manner of searching for gas escapes. An electric lamp fed with a portable accumulator has been selected and rendered obligatory for such operations. This apparatus has been described at length in the French illustrated papers. It might perhaps be improved, but the principle is quite sound, and it is to be regretted that the results of the French experiments have not become known in England.

We have received a communication from Prof. M. Nyrén, Director of the Imperial Observatory at Pulkowa, near St. Petersburg, informing us that the weather there was so cloudy that not a vestige of the moon could be seen on the occasion of the recent total eclipse. In Helsingfors, where Prof. Nyrén happened to be that night on his return journey from abroad, he could distinguish the darkening of the moon's disk through the clouds, but it was too thick to observe the eclipse of the stars. At Dorpat, the second great Russian Observatory, the weather was also entirely unfavourable for observations. This is greatly to be regretted, in view of the elaborate preparations made by the Russian astronomers, to which we referred last week.

The Royal Bohemian Society of Sciences will celebrate its hundredth anniversary at Prague on December 6 next.

The new University building at Vienna was completed on the 11th inst. The new building at Strasburg will be inaugurated on the 26th inst.

The death is announced of Dr. Robert Ave-Lallemant, well known as a traveller in Brazil, who was born at Lübeck in 1812. He died there on October 10. Also of Dr. Wilhelm Gonnermann, a naturalist who, together with Dr. Rabenhorst edited the celebrated "Mycologia Europæa." He died at Coburg, aged seventy-eight years.

The French Minister of Public Instruction has commissioned M. Brau de St. Paul Lias to proceed to Malacca and Sumatra for the purpose of making natural history collections. M. Étienne Gautier is to do the same in Persia and Asiatic Turkey; and Dr. Guardia goes to the Balearic Isles to study the dialect there.

The life of a Ceylon planter appears to be a constant contest with insect pests of one kind and another. A short time since we noticed a correspondence on a "blight" which attacked the tea-plant, and now the Ceylon papers which arrived by the last mail contain a report, by Dr. Trimen, the head of the Botanic Gardens in the colony, on an insect which has caused much alarm by its depredations on cacao and cinchona plantations. He thinks the only serious damage to cacao comes from the *Helopeltis antonii*, which appears to be a recent importation to Ceylon, although well known in Java. It is believed to be still in small numbers, and to be confined to certain localities, and the only remedy suggested by Dr. Trimen is that the planters should have it carefully sought for and destroyed.

We are requested to announce that in future the ordinary meetings of the Essex Field Club will be held in the large hall of the Public Hall, Loughton, Essex. The first meeting of the winter session will be on Saturday next, the 25th inst., at seven o'clock.

A Society has been established at Vladivostok in Eastern Siberia for the purpose of exploring the Amour district, with a view of founding in Vladivostok a museum illustrative of the natural history of the region.

The additions to the Zoological Society's Gardens during the past week include a Meadow Pipit (*Anthus pratensis*), six Twites (*Linota flavirostris*), a Linnet (*Linota cannabina*), eight Lesser Redpolles (*Linota rufescens*), British, presented by Mr. T. E. Gunn; two Robben Island Snakes (*Coronella phocarum*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Hardwick's Mastigure (*Uromastix hardwickii*) from India, presented by Mr. Cuthbert Johnson; a Moustache Monkey (*Cercopithecus cephus*) from West Africa, a Greater Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Australia, a Blue and Yellow Macaw (*Ara ararauna*) from South America, deposited; six Coypus (*Myopotamus coypus*), three Cockateels (*Calopsitta novæ-hollandiæ*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

Wolf's Comet.—The observations of this comet to the end of September having been found irreconcilable with parabolic motion, Prof. Krueger, the editor of the *Astronomische Nachrichten*, and Mr. S. C. Chandler, jun., of Harvard College, have investigated the elements by a general method, and find an elliptic orbit of very limited dimensions, the period of revolution being 6·55 years by Prof. Krueger's calculation, and 6·65 years by Mr. S. C. Chandler's. Other elements by the former calculation are as follows:—

Perihelion passage 1884 November 17·8999 G.M.T.

	° ′ ″	
Longitude of perihelion	19 20 56	M.Eq. 1884·0
,, ascending node	206 35 35	
Inclination	25 3 54	
Angle of eccentricity	33 32 29·7	
Log. semi-axis major	0·544040	
Log. perihelion distance ...	0·194792	

In such an orbit there would be a very close approach to the orbit of Jupiter in about 209° heliocentric longitude, where the distance between the two would be less than 0·12, and with Prof. Krueger's period of revolution there would be great perturbation early in the year 1875, so that it is possible the comet may not have been moving long in its present track. It will be interesting to examine this point further, when the major axis of the comet's orbit has been more accurately determined by a wider extent of observation.

We have thus two comets of short period brought to light in the same year. As regards Barnard's comet the length of revolution appears to be yet somewhat doubtful, Prof. Morrison of Washington assigning 6·43 years, and Dr. Berberich of Strasburg 5·50 years only.

The November Meteors.—Assuming that these bodies are moving strictly in the orbit of the first comet of 1866, we find by Prof. Oppolzer's definitive elements that the nearest approach to the orbit of Mars is in about heliocentric longitude 0°·5, distance 0·30; the nearest approach to the orbit of Jupiter is in 198°·7, distance 0·79; in the case of Saturn the least distance of orbits is 0·46 at 214°·9; and in that of Uranus 0·37 at 234°·2. In 1866 the comet traversed the plane of the earth's orbit in 51°·4, distant therefrom only 0·0066.

NEW SOUTHERN DOUBLE-STARS.—Mr. H. C. Russell, Government Astronomer at Sydney, has circulated a list of newly-detected double-stars, some found by himself with the large instrument, and others by Mr. Hargrave with the $7\frac{1}{4}$-inch equatorial. In most cases the components belong to the tenth and eleventh magnitudes.

THE TOTAL SOLAR ECLIPSE OF 1816, NOVEMBER 19.—The first total eclipse of the sun in the present century in which the central line passed over Europe took place on the morning of November 19, 1816. Maps of its track appeared in the *Berliner Jahrbuch* for 1816, and in the first part of Hallaschka's *Elementa Eclipsium*, where the full computation of this eclipse is given as an example. In Lindenau and Bohnenberger's *Zeitschrift für Astronomie*, vol. v., Hagen gives the moon's place deduced from Burckhardt's Tables, with the horizontal parallax and semi-diameter : if we combine these with similar quantities for the sun, taken from Carlini's Tables of 1833, we find the following elements of the eclipse :—

G.M.T. of Conjunction in R.A. 1816 Nov. 18 at 21h. 46m. 57s.

	°	′	″	
R.A.	234	42	20	
Moon's declination	18	37	9	S
Sun's ,, ...	19	30	29	S
Moon's hourly motion in R.A.... ...		36	58	
Sun's ,, ,, ,, ...		2	37	
Moon's ,, ,, Decl.... ...		11	37	S
Sun's ,, ,, ,, ...		0	38	S
Moon's parallax		60	15	
Sun's ,, ...		0	9	
Moon's semi-diameter		16	25	
Sun's ,, ,, ...		16	12	

In the *Berliner Jahrbuch* Bode makes the eclipse total at both Dantzic and Warsaw ; the above elements do not show totality at either place, but give the magnitudes 0·990 and 0·992 respectively. They indicate, however, a total eclipse at Bromberg, duration 1m. 22s. Possibly there may be other observations of the totality on record, but the only one we have found was made by Hagen at Culm in Bohemia, where he observed its commencement but not the ending. It would appear that the weather at this season was an impediment to observation, or more details of the total phase in its passage over Germany might have been expected. Before the eclipse of July 1842 there was only one in which the line of totality approached near the European continent, viz. that of July 17, 1833, which was total in Iceland ; on Mount Hecla the total eclipse commenced at 4h. 56m. 37s. a.m., and continued two minutes, the sun at an altitude of 13° ; but the days of physical observations had not then arrived, and we do not find it recorded that a midsummer expedition to Iceland was organised.

CHEMICAL NOTES

THERE has of late been a considerable amount of work done on the relations between the composition and structure of chemical compounds and various physical constants of these compounds ; and also on the relations between the conditions of chemical change and some of the physical properties of the constituents of the changing systems. Among the more important work on the former class of relations are to be mentioned Perkin's researches on the *magnetic rotatory polarisation* of compounds (*C. S. Journal*, *Trans.* for 1884, p. 421 *et seq.*) ; and Schiff's researches on the *coefficients of capillarity* of liquid carbon compounds (*Annalen*, ccxxiii. 47). The investigations of Raoult on the connections between the freezing-points of solutions and the distribution of the salts therein form an important contribution to the study of the second group of relations (see especially *Ann. Chim. Phys.* (6), ii. p. 66, *et seq.*). Perkin has measured the rotations of the plane of polarisation of a ray of monochromatic (sodium) light, produced by passing the ray through columns of various liquid carbon compounds placed between the poles of a large electro-magnet. Then, by the use of the formula $\frac{r \times M}{d}$, where r = observed rotation, d = density, and M = molecular weight (as gas), of the given compound, he has calculated the magnetic rotatory effect of unit-length of the liquid obtained by condensing unit-length of the vapour of the same liquid. The observed results are thus referred to lengths of liquid related to each other in the ratio of the molecular weights of the various compounds examined. Each result is divided by the number obtained, by the same method, for water, and the quotient represents the *molecular rotatory power* of the given compound. The molecular rotatory powers of a great many compounds belonging to twenty-six series have been determined, and the results show that the constant in question is closely connected with the valencies of the atoms, and with the distribution of the interatomic actions, in the molecules of the compounds examined. Schiff has made an extended series of determinations of the *coefficients of capillarity*, that is the capillary elevations in tubes 1 mm. radius, of many liquid carbon compounds. By multiplying this constant by the density of the compound, and dividing by 2, another constant is obtained which represents the weight of liquid raised by capillary action through unit-length of the line of contact between the liquid and the containing vessel. Lastly, by dividing the coefficient of capillarity by twice the "molecular volume" $\left(i.e. \frac{\text{molecular weight of gas}}{\text{density of liquid}}\right)$, a quotient is obtained which represents the relative number of molecules raised along the line of contact between the liquid and solid surfaces. Schiff's results, although very numerous, do not yet allow very definite conclusions to be drawn regarding the connection between the three constants and the molecular structure of the compounds examined ; but that a definite connection exists is rendered very probable by these investigations. Raoult has made many determinations of the *molecular lowering of the freezing-point*—that is, the lowering of the freezing-point produced by the solution of 1 gramme-molecule of substance dissolved—of various solvents by acids, bases, and salts. The solvents employed were water, benzene, nitro-benzene, ethylene dibromide, acetic and formic acids. In each case the molecular lowering of the freezing-point is approximately equal to one of two values, of which one is double the other. The acids examined may be divided into two groups as regards their effect on lowering the freezing-point of water. The value of the constant measured by Raoult is approximately 40 for one of the groups, and 20 for the other group. The bases examined likewise fall into two groups ; the mean values of the constants being 39 and 19 respectively. Raoult states that the acids with the higher value (40) almost completely displace the acids with the lower value (20) from their combinations with bases, when the acids and salts react in equivalent quantities. The bases of the first group almost completely displace those of the second from their combinations with acids. Measurements of the molecular lowering of the freezing-point of water by the action of acids, bases, and salts, present us with data from which, according to Raoult, the distribution of the various acids, &c., in a changing chemical system may be deduced.

AMERICAN ORNITHOLOGISTS' UNION

THE second annual meeting of the American Ornithologists' Union was held in the American Museum of Natural History, New York City, September 30 to October 2, 1884, the President, Mr. J. A. Allen, in the chair.

The Active Members present were: J. A. Allen, H. B. Bailey, Chas. F. Batchelder, Eugene P. Bicknell, William Brewster, Montague Chamberlain, Dr. Elliott Coues, D. G. Elliot, Dr. A. K. Fisher, Col. N. S. Goss, Dr. J. B. Holder, Dr. C. Hart Merriam, Robert Ridgway, Thomas S. Roberts, John H. Sage, George B. Sennett, Dr. Leonhard Stejneger.

Dr. Philip Lutley Sclater, Mr. Howard Saunders, and the Rev. E. P. Knubley, of the British Ornithologists' Union, were also present, and were cordially invited to take part in the proceedings of the Union.

The Associate Members in attendance were William Dutcher, Fred T. Jencks, and Dr. Howard Jones.

On the recommendation of the Council the following persons were elected to Foreign Membership :—Heinrich Gätke, Heligoland ; Dr. W. Taczanowski, Russia ; Henry Seebohm, England ; Howard Saunders, England ; Dr. H. Burmeister, Brazil.

The following among others were elected Corresponding Members :—Dr. John Anderson, F.R.S., India ; W. T. Blanford, F.R.S., London ; Major H. W. Feilden, London ; Dr. Hans Gadow, England ; Col. H. H. Godwin-Austen, London ; Dr. Julius von Haast, New Zealand ; Dr. E. Holub, Austria ; Dr. C. F. Homeyer, Germany ; E. L. Layard, New Caledonia ; Dr. A. B. Meyer, Germany ; Dr. A. von Mojsisovics, Gratz ; Dr. A. J. Malmgren, Finland , Dr. A. von Middendorff, Russia; Col. N. Przevalsky, Russia; Dr. Gustav Radde, Russia; Dr. Leopold von Schrenck, Russia; Dr. W. Severtzow, Russia; Rev. Canon H. B. Tristram, England; Dr. Hjalmar Theel, Sweden.

The report of the Committee on Revision of Nomenclature and Classification of North American Birds was presented by the Chairman, Dr. Elliott Coues, who said that the work of the Committee had been divided by the creation of two Sub-Committees: one (consisting of Messrs. Ridgway, Brewster, and Henshaw) to determine the status of species and sub-species; the other (consisting of Mr. Allen and Dr. Coues) to formulate the canons of nomenclature and classification adopted by the Committee. He also expressed the indebtedness of the Committee to Dr. Leonhard Stejneger for determining many points in synonymy, and for other aid. Dr. Coues then read at length the report of the Sub-Committee on Codification of Canons of Nomenclature and Classification, as adopted by the full Committee. The reading occupied about an hour and a half. Mr. Ridgway continued the report by reading the list of species prepared by the Sub-Committee on the Status of Species and Sub-Species as adopted by the full Committee. The Committee unanimously adopted the tenth edition of Linnæus's "Systema Naturæ" as the starting-point in zoological nomenclature; it unflinchingly avowed its adherence to the rule of priority; and emphatically and unequivocally indorsed the employment of trinomials in the designation of sub-species.

The report of the Committee on Bird Migration was presented by the Chairman, Dr. C. Hart Merriam. Dr. Merriam stated that a circular had been issued setting forth the objects and methods of the Committee, specifying the division of the territory of the United States and British North America into thirteen districts (each of which had been placed in charge of a competent superintendent), and supplying instructions to observers concerning the data desired—which were classed under the heads of Ornithological, Meteorological, and Contemporary and Correlative Phenomena.

In order to secure a large number of observers, the Chairman had written to the editors of eight hundred newspapers, asking them to call attention to the work of the Committee and to state that more observers were desired. The several superintendents had also written to a large number of papers—just how many the Chairman was not aware. The Press very kindly gave the matter the prominence its importance deserved, and abstracts of the circulars, amounting in some cases to an actual reprint, and usually coupled with editorial comment, were published in several hundred newspapers. This resulted in the receipt by the Chairman of upwards of three thousand applications for circulars of information and instruction. In all, nearly six thousand circulars were distributed. By this means the Committee finally secured nearly seven hundred observers, in addition to the keepers of lights. The observers are distributed as follows:—Mississippi Valley district, Prof. W. W. Cooke, Superintendent, 170; New England district, John H. Sage, Superintendent, 142; Atlantic district, Dr. A. K. Fisher, Superintendent, 121; Middle-Eastern district, Dr. J. M. Wheaton, Superintendent, 90; Quebec and the Maritime Provinces, Montague Chamberlain, Superintendent, 56; district of Ontario, Thomas McIlwraith, Superintendent, 38; Pacific district, L. Belding, Superintendent, 30; Rocky Mountain district, Dr. Edgar A. Mearns, Superintendent, 14; Manitoba, Prof. W. W. Cooke, Superintendent, 10; British Columbia, John Fannin, Superintendent, 5; North-West Territories, Ernest E. T. Seton, Superintendent, 5; Newfoundland, James P. Howley, Superintendent (returns not yet received). Migration stations now exist in every State and Territory in the Union excepting Delaware and Nevada.

The Committee was fortunate in obtaining the co-operation of the Department of Marine and Fisheries of Canada, and of the Lighthouse Board of the United States. By this means it secured the free distribution of upwards of twelve hundred sets of schedules and circulars to the keepers of lighthouses, lightships, and beacons in the United States and British North America.

The returns thus far received from observation were exceedingly voluminous and of great value. They were so extensive, indeed, that it was utterly impossible for the Committee to elaborate them without considerable pecuniary aid.

In order to show the Union the character and extent of the labours of the Committee, the Chairman had requested the superintendents of all districts east of the Rocky Mountains to prepare reports upon five common, well-known, and widely-distributed birds, to wit: the robin (*Merula migratoria*), catbird (*Mimus carolinensis*), Baltimore oriole (*Icterus gabula*), purple martin (*Progne subis*), and nighthawk (*Chordeiles popetue*). This had been done, and the reports received were presented for examination. The Chairman directed special attention to those prepared by Dr. J. M. Wheaton and Dr. A. K. Fisher as examples of tabulated returns, and to that received from Prof. W. W. Cooke as an example of the generalisation of results.

The Chairman called attention to the action of the International Ornithologists' Congress held in Vienna last April, stating that he had been instructed (in common with the delegates from other countries) to represent the cause of the Committee in the National Government, begging it "to further to the utmost the organising of migration stations," and "to appropriate a sufficient sum for the support of these stations, and for the publication of annual reports of the observations made."

The Council was instructed to memorialise the Congress of the United States, and the Parliament of Canada, in behalf of the work of the Committee on Bird Migration.

On the motion of Mr. Brewster, the Committee on Geographical Distribution was merged into the Committee on Migration as a Sub-Committee, the whole Committee to be entitled a "Committee on the Migration and Geographical Distribution of North American Birds."

The Report of the Committee on the Eligibility or Ineligibility of the European House-Sparrow in America was presented by Dr. J. B. Holder, Chairman of the Committee. Dr. Holder said that a circular of inquiry had been printed, and about one thousand copies circulated in Canada and the United States. Particular pains had been taken to secure evidence from those who advocated the cause of the sparrow. A large number of returns had been received, and the evidence for and against the naturalised exotic had been carefully sifted and summarised. The result overwhelmingly demonstrated that the sum of its injurious qualities far exceeds and cancels the sum of its beneficial qualities. In other words, it was the verdict of the Committee that the European house-sparrow is not an eligible bird in North America. The Union sustained the decision of the Committee.

The Report of the Committee on Faunal Areas was presented by the Chairman, Mr. J. A. Allen. Mr. Allen said that, for the purposes of the Committee, North America had been divided into several districts, each of which had been placed in charge of a member of the Committee as follows:—Arctic and British America and the northern tier of States bordering the Great Lakes, from New York to Minnesota inclusive, were being worked by Dr. C. Hart Merriam; Canada, south of the St. Lawrence, and New England, by Arthur P. Chadbourne; the Eastern and Middle States, from New Jersey to Florida, and west to the Mississippi River, by Dr. A. K. Fisher; the Rocky Mountain region by Dr. Edgar A. Mearns; and the Pacific region by L. Belding. It was the plan of the Committee to collate and tabulate the required data from all published sources; to avail itself in like manner of the material contained in the returns of the observers of bird migration (this privilege having been granted by the Committee on Bird Migration); to illustrate the facts thus obtained by coloured maps showing the summer and winter range of each species; and to generalise the final results and place the same before the Union, accompanied by coloured charts showing, with as much precision as possible, the exact limits of the several *faunal areas* in North America.

Dr. P. L. Sclater said he was glad to know that North America, which he knew as a *Nearctic* region, was being worked in so thorough a manner by so competent a Committee, and that the results obtained could not fail to be of great interest and value.

The matter of the wholesale slaughter of our native birds for millinery and other purposes was brought forcibly before the Union by Mr. Wm. Brewster, and a Committee was appointed for the protection of North American birds and their eggs against wanton and indiscriminate destruction.

Dr. Merriam spoke of the capture, just two weeks previously (September 19), of a second specimen of the wheatear (*Saxicola œnanthe*) at Godbout, on the north shore of the St. Lawrence, by Mr. Napoleon A. Comeau. Mr. Comeau exhibited the bird, a handsome male, and said that he shot the first specimen at the same place on May 18 last. He also spoke of the capture at Godbout of the European house-sparrow (*Passer domesticus*), thus extending the known range of the species, on the north shore, by at least 250 miles.

Dr. Leonhard Stejneger exhibited a stuffed specimen of a willow grouse from Newfoundland, which he regarded as a new geographical race, differing from the continental form chiefly in the possession of more or less black upon its primaries. Mr. Brewster said that he had recently examined 150 specimens of ptarmigan from Newfoundland, and had observed the peculiarities pointed out, but did not consider them constant. He was inclined to regard the characters mentioned as seasonal, and possibly to some extent individual. Dr. Stejneger replied that this coloration of the wing feathers could not possibly be seasonal as they (the primaries) were moulted but once a year. Dr. Merriam stated that during a recent visit to Newfoundland he had examined a very large number of willow grouse in the flesh, and was still engaged in investigating the change of colour in this species. His studies led him to disagree with Dr. Stejneger's last statement. He (Dr. Merriam) was convinced that change in colour in individual feathers did take place, both independent of and coincident with the moult. Mr. D. G. Elliot agreed with Mr. Merriam in considering the change of colour of individual feathers an established fact. An animated discussion followed, and was participated in by Messrs. Brewster, Comeau, Coues, Elliot, Merriam, Ridgway, and Stejneger.

In response to a call from the President, Dr. P. L. Sclater said:—

"I hope the members of the American Ornithologists' Union will excuse me if I offend the feelings of any one by the remarks I am about to make. It has aggrieved me much to find in this country three large and valuable collections of birds which are not under the care of paid working ornithologists. One of these is in Boston, one in New York, and the other in Philadelphia. Each contains what all ornithologists admit to be most valuable typical specimens. A grave responsibility rests upon the possessors of types of species, and the loss or injury of such specimens is a great and irreparable loss to science. The collection of the Boston Society of Natural History (known as the La Frenayé Collection) has been much damaged by neglect, and the entire collection ought to be catalogued and so arranged as to render any particular specimen readily accessible. In this building (the American Museum of Natural History in New York) are the types of the celebrated Maximilian Collection, and many other specimens of exceeding great value. A large number of these have never been properly identified, and some of them are missing and have doubtless been destroyed by insect pests. The value of others has been lost through neglect, by the displacement of labels, and by the omission of proper measures for their preservation. The same remarks would, in a general way, apply to the collections of the Philadelphia Academy of Natural Sciences. It is sad to find no paid ornithologists in charge of these exceedingly valuable collections, and I beg to suggest that the American Ornithologists' Union can undertake no worthier task than to impress upon the proper authorities the urgent necessity of immediate action in this matter."

The officers of the Union were re-elected as follows:—President, J. A. Allen, Cambridge; Vice-Presidents, Dr. Elliott Coues and Robert Ridgway, Washington; Secretary and Treasurer, Dr. C. Hart Merriam, Locust Grove, New York.

The place of meeting for next year was referred to the Council for decision.

THE CAPILLARY CONSTANTS OF LIQUIDS AT THEIR BOILING-POINTS

THE paper of Prof. Robert Schiff, published in *Liebig's Annalen*, March 1884, on this subject, marks the first successful attempt out of many that have been made to connect the surface-tension of a liquid with its molecular constitution.

It has long been known that the tension diminishes rapidly with a rise of temperature, but the importance of this fact when it is desired to make a comparative examination of different liquids has not been fully appreciated or sufficiently insisted on till now by Prof. Schiff, who has to lament that, out of the considerable array of experimental investigations on the subject which he has examined, very few results could be extracted which could be usefully employed in such a comparative study, a failure which he attributes to the completely arbitrary and dissimilar physical conditions under which the different substances in question have been examined.

Since it is impossible to compare surface-tensions at the critical point, because that is the point at which the surface-tension vanishes, it is necessary to seek some other condition in which different liquids may be physically comparable, and that which naturally suggested itself for trial to Prof. Schiff, was the boiling-point of the liquid itself, whose significance in this respect he has himself established.

The principle of his method was to select with great care two capillary glass tubes of perfectly cylindrical bore, but of different diameters, that of the wider being about 1·3 mm., and of the narrower about half as much. These two tubes are then united into a little U-tube (about 7 cm. long), which, after being partly filled with the experimental liquid, is hung in a wider vessel, at the bottom of which a little of the same liquid is kept boiling. From the difference of level of the liquid in these two connected capillary tubes, as measured at a temperature which must be very nearly the boiling-point, the surface-tension at that temperature is readily deduced, since the method of procedure involves the thorough wetting of the upper portion of the tube with condensed liquid.

In this manner Prof. Schiff has determined the surface-tension at the boiling-point of some sixty liquids, with a possible error which he estimates at 1·75 per cent. of the mean value—at the worst, 2·4 per cent. His results may be stated as follows:—

1. For isomeric liquids that are chemically comparable, the surface-tension at the boiling-point is the same (within the limits of observational error). The observations do indeed point in the case of isomers of one class to a fall in surface-tension with a fall in the boiling-point, while in another class there is a perceptible rise with a rise in the boiling-point, but these variations are within the limits of possible errors of observation.

2. The quantity which turns out to be that on which attention should be fixed is not the surface-tension itself, but the surface-tension divided by the molecular weight, a quantity to which the author gives a vivid significance by pointing out that, in the case of a capillary elevation against a vertical wall wetted by the liquid, it is proportional to and represents the *number of molecules raised above the free surface per unit length of the wall;* for, since the tension per unit length is equal to the weight of the total number of molecules lifted, this tension divided by the weight of each molecule gives the total number lifted.

To the surface-tension in milligrams per millimetre divided by the relative molecular weight (and multiplied for convenience by 1000), Prof. Schiff accordingly assigns the symbol N, and his results show that not only is this number N the same for isomeric substances (as is implied in the previous statement), but that it is often the same for liquids of very different chemical constitution. He then proceeds to examine the formulæ of such chemically different liquids which have the common property that N is the same, in the manner exemplified in the following illustration:—

"Taking all the different substances for which N is nearly 16, we find—

Hexane, C_6H_{14} ... ... N = 16·1

Xylol, ethyl-benzol, C_8H_{10}... N = 16·0, 15·9, 15·8, 16·2

With the formula $C_5H_{10}O_2$ ... N = 15·8, 15·6, 15·6, 15·9, 15·7

"This indicates that substances with the formulæ

C_6H_{14}, C_8H_{10}, $C_5H_{10}O_2$,

are, so far as concerns the value of the number (N) of molecules lifted, equivalent to each other.

"C_6H_{14} differs from C_8H_{10} in having C_2 less and H_4 more; accordingly, so far as concerns the constant N,

$$2C = 4H.$$

"C_8H_{10} differs from $C_5H_{10}O_2$ in having C_3 more and O_2 less, so that, with reference to the constant N,

$$3C = 2O."$$

In order to test whether these equivalences are accidental or not, he examines other series, for which N has respectively the value 10·5, 13, 27, &c., but always with the same result, so that he concludes that these equivalences are not chance coincidences, but that *it is really possible to replace a certain number of atoms of one kind by a certain number of another kind without producing in the value of* N *an alteration which comes within the limits of precise observation.*

From the equivalences $2C = 4H$ and $3C = 2O$
it follows that $C = 2H$
and $O = 3H$,
while from a similar examination of liquids containing chlorine he deduces $Cl = 7H$.

These equivalences enable him to write down what may be called the hydrogen equivalent, with respect to the value of the number N, of any compound of the four elements in question, *i.e.* the number of hydrogen atoms, which, if they existed as a molecule in the free state, would constitute a substance for which the value of N at the boiling-point would be the same as for the original substance. Thus, selecting a few substances whose hydrogen equivalents are tolerably evenly distributed over the range that he has examined, he obtains the following table:—

	H	N
CH_4O	$= H_9$ ...	59·8
C_2H_6O	$= H_{13}$ ...	38·4
C_3H_8O	$= H_{17}$ ...	29·0
$C_3H_6O_2$	$= H_{18}$ ...	27·0
$C_4H_8O_2$	$= H_{22}$ ...	20·4
C_8H_{10}	$= H_{26}$ ...	16·1
C_9H_{12}	$= H_{30}$ ...	13·1
C_8H_{18}	$= H_{34}$ ...	10·5
$C_8H_{16}O_2$	$= H_{38}$ ...	8·7
$C_{10}H_{22}$	$= H_{42}$ ...	7·7

From these observations as data, a curve is easily drawn of which the ordinates are proportional to the number of atoms in the hydrogen equivalent and the abscissæ to the corresponding value of N; and it is remarkable that the curve so drawn is of equable curvature, and corresponds equally well, not only to the selected data from which it is plotted, but also to all the other observed values of N, so that by transforming the molecular formula of any liquid into its hydrogen equivalent we can at once find, by reference to the curve, the value of N for the substance, and, by multiplying this by $\frac{\text{mol. weight}}{1000}t$, we obtain the surface-tension at the boiling-point.

There are only three liquids for which Prof. Schiff notices that the value of N, as calculated from the curve, differs markedly from the observed value. These are—

Amylene (C_5H_{10}), for which	N (obsd.) = 22,	and N (calcd.) = 23·4
Diallyl (C_6H_{10}) ,,	,, = 18·4	,, = 20·5
Ethylene-chloride ($C_2H_4Cl_2$) ,,	,, = 24·6	,, = 20·5

In the first case the disagreement is explained by the presence of impurity; in the second, impurity is very possibly the cause; while in the third it is possible that the equation $Cl = H_7$ is not applicable to substances in whose formula more than a single carbon atom is represented, a point which the author hopes to clear up by further investigation. We observe, however, that to these disagreements should be added the case of ethyl-isobutyrate $C_6H_{12}O_2$), for which N as given by the curve is 13·1, while the observed value was 12·3, a deviation of 7·5 per cent. On this the author makes no remark.

We will venture here to call attention also to a slight error that pervades all Prof. Schiff's results. We refer to the manner in which he corrects for the meniscus. The importance of this correction is in these measures very considerable, since the total elevation observed is always less than 10 mm. and sometimes less than 5 mm., and the correction is sometimes as much as 2 per cent. of the whole. Prof. Schiff, rejecting as insufficiently accurate Laplace's correction, which is based on the assumption that the surface of the meniscus may be regarded as that of a hemisphere of the same radius as the tube, and which consists therefore in adding to the observed height one-third of this radius, prefers to measure the height of the meniscus directly and to take as the correction one-third of the arithmetical mean between the observed height and the radius of the tube. In doing this he assumes that the surface may be regarded as that of a sphere of radius very appreciably greater than that of the tube, and gives a diagram in which it is so represented; but if this assumption or representation were correct, the laws of capillary tubes would be very different from what they are; moreover, according to theory, the form of the meniscus, and therefore the correction, must always be the same for liquids with the same capillary elevation; but Prof. Schiff's correction, based on the direct measurement of the meniscus, varies very considerably for elevations that are almost identical, which shows that the measures of the meniscus are not to be relied on: thus in the case of ethyl-toluol (para) (C_9H_2) the elevation is ·603 cm., and the correction ·013 cm., while for isobutyl-formiate ($C_5H_{10}O_2$) the elevation is ·599 cm., but the correction ·008 c.m., and in many cases one of two liquids which must theoretically have the greater correction has in point of fact the smaller. In order to see how far the empirical correction was at fault, we have selected one of Prof. Schiff's measures in which the elevation has about its mean value, and have calculated for comparison the correction of Hagen and Desains, which is based on the very approximately accurate assumption that the meniscus may be regarded as an oblate spheroid, and which is said to have been verified (? in the case of water) for tubes whose diameter attained as much as 4·6 mm. The following is the result:—

			mm.
Propyl Formiate:	observed elevation	=	6·45
,, ,,	Laplace's correction	=	− 0·1046
,, ,,	Hagen and Desains' correction	=	− 0·102
,, ,,	Schiff's correction	=	− 0·07

Corrected value (Schiff) 6·38; (Hagen and Desains), 6·348 mm.

It will thus be seen that an error of about ½ per cent. in the value of the surface-tension has entered into the result on this occasion, and that more has been lost than gained by substituting the empirical correction for that of Laplace; in some cases the error will be rather greater.

The importance in molecular physics of the step which Prof. Schiff has taken cannot easily be overrated. If it were only that he had found that isomeric substances have the same surface-tension at the boiling-point, that alone would have been a fact of great importance in reference to the interpretation of what we are accustomed to call the internal vapour-tension in a liquid; but in the system of absolute atomic equivalences with respect to surface-tension, and the knowledge of the manner in which the surface-tension varies with variations of the atomic equivalent, he has given to the physicist now for the first time most important data for correlating the surface-tension with the molecular actions existing expectively in the mass of the liquid and in the vapour above it. A. M. W.

RESEARCHES ON THE ORIGIN AND LIFE-HISTORIES OF THE LEAST AND LOWEST LIVING THINGS [1]

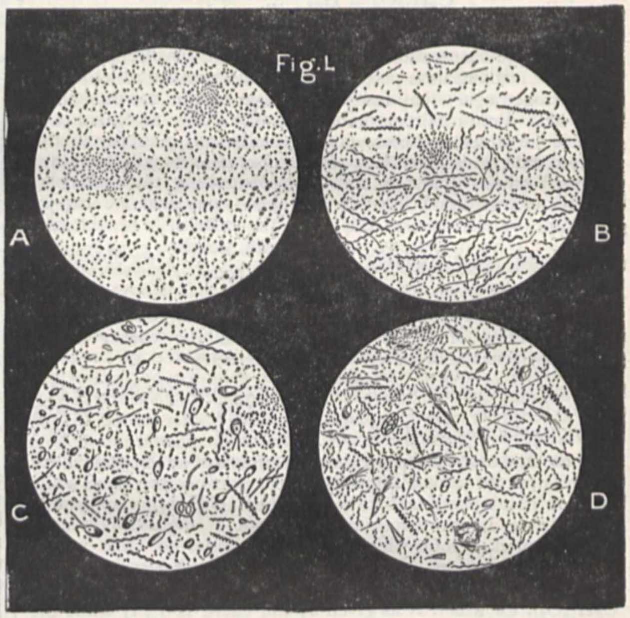
To all who have familiarised themselves, even cursorily, with modern scientific knowledge, it is well known that the mind encounters the *infinite* in the contemplation of minute, as well as in the study of vast natural phenomena. The farthest limit we have reached, with the most gigantic standard of measurement we could well employ, in gauging the greatness of the universe, only leaves us with an overwhelming consciousness of the awful greatness—the abyss of the infinite—that lies beyond, and which our minds can never measure. The indefinite has a limit somewhere; but it is not the indefinite, it is the measureless, the infinite, that vast extension forces upon our minds. In like manner, the immeasurable in minuteness is an inevitable mental sequence from the facts and phenomena revealed to us by a study of the *minute* in nature. The practical divisibility of matter disclosed by modern physics may well arrest and astonish us. But biology, the science which investigates the phenomena of all living things, is in this matter no whit behind. The most universally diffused organism in nature, the least in size with which we are definitely acquainted, is so small that fifty millions of them could lie together in the one-hundredth of an inch square. Yet these definite living things have the power of locomotion, of ingestion, of assimilation, of excretion, and of enormous multiplication, and the material of which the inconceivably minute living speck is made, is a highly complex chemical compound. We dare not attempt a conception of the minuteness of the ultimate atoms that compose the several simple elements that thus mysteriously combine to form the complex substance and properties of this least and lowliest living thing. But if we could even measure these, as a mental necessity, we are urged indefinitely on to a minuteness without conceivable limit, in effect, a minuteness that is beyond all finite measure or conception. So that, as modern physics and optics have enabled us not to conceive merely, but to actually realise, the vastness of spatial extension, side by side

[1] By Rev. W. H. Dallinger, LL.D., F.R.S., F.L.S., Pres.R.M.S.

with subtle tenuity and extreme divisibility of matter, so the labour, enthusiasm, and perseverance of thirty years, stimulated by the insight of a rare and master mind, and aided by lenses of steadily advancing perfection, has enabled the student of life-forms not simply to become possessed of an inconceivably broader, deeper, and truer knowledge of the great world of visible life, of which he himself is a factor; but also to open up and penetrate into a world of minute living things so ultimately little that we cannot adequately conceive them, which are, nevertheless, perfect in their adaptations and wonderful in their histories. These organisms, whilst they are the least, are also the lowliest in Nature, and are to our present capacity totally devoid of what is known as organic structure, even when scrutinised with our most powerful and perfect lenses. Now these organisms lie on the very verge and margin of the vast area of what we know as living. They possess the essential properties of life, but in their most initial state. And their numberless billions, springing every moment into existence wherever putrescence appeared, led to the question, "How do they originate?" Do they spring up *de novo* from the highest point on the area of *not-life*, which they touch? Are they, in short, the direct product of some yet uncorrelated force in nature, changing the dead, the unorganised, the not-living into definite forms of life? Now this is a profound question, and that it is a difficult one there can be no doubt. But that it is a question for our laboratories is certain. And after careful and prolonged experiment and research the legitimate question to be asked is, Do we find that in our laboratories and in the observed processes of Nature now, that the not-living can be, without the intervention of living things, changed into that which lives?

To that question the vast majority of practical biologists answer without hesitancy, *No*, we have no facts to justify such a conclusion. Prof. Huxley shall represent them. He says, "The properties of living matter distinguish it absolutely from all other kinds of things," and, he continues, "the present state of our knowledge furnishes us with no link between the living and the not-living." Now let us carefully remember that the great doctrine of Charles Darwin has furnished biology with a magnificent generalisation: one indeed which stands upon so broad a basis that great masses of detail and many needful interlocking facts are, of necessity, relegated to the quiet workers of the present, and the earnest labourers of the years to come. But it is a doctrine which cannot be shaken. The constant and universal action of variation, the struggle for existence, and the "survival of the fittest," few who are competent to grasp will have the temerity to doubt. And to many, that which lies within it as a doctrine, and forms the fibre of its fabric, is the existence of a continuity, an unbroken stream of unity running from the base to the apex of the entire organic series. The plant and the animal, the lowliest organised and the most complex, the minutest and the largest, are related to each other so as to constitute one majestic organic whole. Now to this splendid continuity practical biology presents no adverse fact. All our most recent and most accurate knowledge confirms it. But *the* question is, Does this continuity terminate now in the living series, and is there then a break—a sharp, clear discontinuity, and beyond, another realm immeasurably less endowed, known as the realm of not-life? or, Does what has been taken for the clear-cut boundary of the vital area, when more deeply searched, reveal the presence of a force at present unknown, which changes not-living into the living, and thus makes all nature an unbroken sequence and a continuous whole? That this is a great question, a question involving large issues, will be seen by all who have familiarised themselves with the thought and fact of our times. But we must treat it purely as a question of science; it is not a question of *how* life *first* appeared upon the earth, it is only a question of whether there is any natural force *now* at work building not-living matter into living forms. Nor have we to determine whether or not, in the indefinite past, the not-vital elements on the earth, at some point of their highest activity, were endowed with, or became possessed of, the properties of life.

On that subject there is no doubt. The elements that compose protoplasm—the physical basis of all living things—are the familiar elements of the world without life. The mystery of life is not in the elements that compose the vital stuff. We know them all, we know their properties. The mystery consists *solely* in *how* these elements can be so combined as *to acquire* the transcendent properties of life. Moreover, to the investigator it is not a question of *by what means* matter dead—without the shimmer of a vital quality—became either slowly or suddenly possessed of the properties of life. Enough for us to know that whatever the power that wrought the change, that power was competent, as the issue proves. But that which calm and patient research has to determine is whether matter demonstrably *not living* can be, without the aid of organisms already living, endowed with the properties of life. Judged of hastily, and apart from the facts, it may appear to some minds that an origin of life from not-life, by sheer physical law, would be a great philosophical gain; an indefinitely strong support of the doctrine of evolution. If this were so, and, indeed, so far as it is believed to be so, it would speak and does speak volumes in favour of the spirit of science pervading our age. For although the vast majority of biologists in Europe and America accept the doctrine of evolution, they are almost unanimous in their refusal to accept as in any sense competent the reputed evidence of "spontaneous generation"; which demonstrates, at least, that what is sought by our leaders in science is not the mere support of hypotheses, cherished though they may be: but the truth, the uncoloured truth, from nature. But it must be remembered that the present existence of what has been called "spontaneous generation," the origin of life *de novo* today, by physical law, is by no means required by the doctrine of evolution. Prof. Huxley, for example, says, "If all living beings have been evolved from pre-existing forms of life, it is enough that a single particle of protoplasm should *once* have



appeared upon the globe, as the result of no matter what agency; any further independent formation of protoplasm would be sheer waste." And why? we may ask. Because one of the most marvellous and unique properties of protoplasm, and the living forms built out of it, *is the power* to multiply indefinitely and for ever! What need, then, of spontaneous generation? It is certainly true that evidence has been adduced purporting to support, if not establish, the origin in dead matter of the least and lowest forms of life. But it evinces no prejudice to say that it is inefficient. For a moment study the facts. The organisms which were used to test the point at issue were those known as *Septic*. The vast majority of these are inexpressibly minute. The smallest of them, indeed, is so small that, as I have said, fifty millions of them, if laid in order, would only fill the one-hundredth part of a cubic inch. Many are relatively larger, but all are supremely minute. Now, these organisms are universally present in enormous numbers, and ever rapidly increasing in all moist putrefactions over the surface of the globe.

Take an illustration prepared for the purpose and taken direct from nature. A vessel of pure drinking water was taken during the month of July at a temperature of 65° F., and into it was dropped a few shreds of fish muscle and brain. It was left uncovered for twelve hours; at the end of that time a small blunt rod was inserted in the now somewhat opalescent water, and a minute drop taken out and properly placed on the microscope, and, with a lens just competent to reveal the minutest objects, examined. The field of view presented is seen in Fig. 1, A. But—with the exception of the dense masses which are known as zoogloea or bacteria, fused together in living glue—the whole field was teeming with action. Each minute organism gyrating in its own path, and darting at every visible point. The same fluid was now left for sixteen hours, and once more a minute drop was taken and examined with the same lens as before. The field presented to the eye is depicted in Fig. 1, B, where it is visible that whilst the original organism persists yet a new organism has arisen in and invaded the fluid. It is a relatively long and beautiful spiral form, and now the movement in the field is entrancing. The original organism darts with its vigour and grace, and rebounds in all directions. But the spiral forms revolving on their axes glide like a flight of swallows over the ample area of their little sea. Ten hours more elapsed and, without change of circumstances, another drop was taken from the now palpably putrescent fluid. The result of examination is given in Fig. 1, C, where it will be seen that the first organism is still abundant, the spiral organism is still present and active, but a new and oval form, not a bacterium, but a *monad*, has appeared. And now the intensity of action and beauty of movement throughout the field utterly defy description, gyrating, darting, spinning, wheeling, rebounding with the swiftness of the grayling and the beauty of the bird. Finally, at the end of another eight to sixteen hours, a final "dip" was taken from the fluid, and under the same lens it presented as a field what is seen in Fig. 1, D, where the largest of the putrefactive organisms has appeared and has even more intense and more varied movements than the others. Now the question before us is, "How did these organisms arise?" The water was pure; they were not discoverable in the fresh muscle of fish. Yet in a dozen hours the vessel of water is peopled with hosts of individual forms which no mathematics could number! How did they arise? from universally diffused eggs? or from the direct physical change of dead matter into living forms? Twelve years ago the life-histories of these forms were unknown. We did not know biologically how they developed. And yet with this great deficiency it was considered by some that their mode of origin could be determined by heat experiments on the adult forms. Roughly the method was this. It was assumed that nothing vital could resist the boiling point of water. Fluids, then, containing full-grown organisms in enormous multitudes, chiefly bacteria, were placed in flasks, and boiled for from five to ten minutes. While they were boiling the necks of the flasks were hermetically closed; and the flask was allowed to remain unopened for various periods. The reasoning was: "Boiling has killed all forms of vitality *in* the flask; by the hermetical sealing nothing living can gain subsequent access to the fluid; therefore, if living organisms do appear when the flask is opened, they must have arisen in the dead matter *de novo* by spontaneous generation, but if they do never so arise the probability is that they originate in spores or eggs."

Now it must be observed concerning this method of inquiry that it could never be final: it is incompetent by deficiency. Its results could never be exhaustive until the life-histories of the organisms involved were known. And further: although it is a legitimate method of research for partial results, and was of necessity employed, yet it requires precise and accurate manipulation. A thousand possible errors surround it. It can only yield scientific results in the hands of a master in physical experiment. And we find that when it has secured the requisite skill, as in the hands of Prof. Tyndall, for example, the result has been the irresistible deduction that living things have never been seen to originate in not-living matter. Then the ground is cleared for the strictly biological inquiry, How do they originate? To answer that question we must study the life-histories of the minutest forms with the same continuity and thoroughness with which we study the development of a crayfish or a butterfly. The difficulty in the way of this is the extreme minuteness of the organisms. We require powerful and perfect lenses for the work. Happily during the last fifteen years the improvement in the structure of the most powerful lenses has been great indeed. Prior to this time there were English lenses that amplified enormously. But an enlargement of the image of an object avails nothing, if there be no concurrent disclosure of detail. Little is gained by expanding the image of an object from the ten-thousandth of an inch to an inch, if there be not an equivalent revelation of hidden details. It is in this revealing quality, which I shall call *magnification* as distinct from *amplification*, that our recent lenses so brilliantly excel. It is not easy to convey to those unfamiliar with objects of extreme minuteness a correct idea of what this power is. But at the risk of extreme simplicity, and to make the higher reaches of my subject intelligible to all, I would fain make this plain.

But to do so I must begin with familiar objects, objects used solely to convey good relative ideas of minute dimension. I begin with small objects with the actual size of which you are familiar. All of us have taken a naked-eye view of the sting of the wasp or honey-bee; we have a due conception of its size. This is the scabbard or sheath, which the naked eye sees.[1] Within this are two blades, terminating in barbed points. The point of the scabbard more highly magnified is presented, showing the inclosed barbs. One of the barbs, looked at on the barbed edge, is also seen. Now these two barbed stings are tubes, with an opening in the end of the barb. Each is connected with the tube of the sac C. This is a reservoir of poison, and D is the gland by which it is secreted. Now I present this to you, not for its own sake, but simply for the comparison, a comparison which struck the earliest microscopists. Here is the scabbard carefully rendered. One of the stings is protruded below its point, as in the act of stinging: the other is free to show its form. Now the actual length of this scabbard in nature was the *one-thirtieth* of an inch. I have taken the point C of a fine cambric sewing needle, and broken it off to slightly less than the one-thirtieth of an inch, and magnified it as the sting is magnified. Now here we obtain an instance of what I mean by magnification. The needle-point is not merely bigger, unsuspected details start into view. The sting is not simply enlarged, but all its structure is revealed. Nor can we fail to note that the *finish* of art differs from that of Nature. The homogeneous gloss of the needle disappears under the fierce scrutiny of the lens, and its delicate point becomes furrowed and riven. But Nature's finish reveals no flaw, it remains perfect to the last.

We may readily amplify this. The butterflies and moths of our native lands we all know; most of us have seen their minute eggs. Many are quite visible to the unaided eye; others are extremely minute. A gives the egg of the Small White Butterfly,[2] B that of the Small Tortoiseshell, C that of the Waved Umber Moth, D that of the Thorn Moth, E that of the Shark Moth, at F we have the delicate egg of the Small Emerald Butterfly, and at G an American Skipper, and finally at H the egg of a moth known as Mania Maura. In all this you see a delicacy of symmetry, structure and carving, not accessible to the eye, but clearly unfolded. We may, from our general knowledge, form a correct notion of the average relation in size existing between butterflies and their eggs; so that we can compare. Now there is a group of extremely minute insect-like forms that are the parasites of birds. Many of them are just plainly visible to the naked eye, others are too minute to be clearly seen, and others yet again wholly elude the unaided sight. The e Epizoa generally lodge themselves in various parts of the plumage of birds; and almost every group of birds becomes the host of some specific or varietal form with distinct adaptations. There is here seen a parasite that secretes itself in the inner feathers of the peacock, this is a form that attacks the jay, and here is one that secretes itself beneath the plumage of the partridge.

Now these minute creatures also deposit eggs. They are placed with wonderful instinct in the part of the plumage and the part of the feather which will most conserve their safety; and they are either glued or fixed by their shape or by their spine in the position in which they shall be hatched. I show here a group of the eggs of these minute creatures. I need not call your attention to their beauty; it is palpable. But I am fain to show you that, subtle and refined as that beauty is, it is clearly brought out. The flower-like beauty of the egg of the peacock's parasite, the delicate symmetry and subtle carving of the others simply entrance an observer. Note then that it is not merely *enlarged* specks of form that we are beholding, but such true magnifications of the objects as bring out all their subtlest details. And it is *this* quality that must characterise our most powerful lenses. I am almost compelled to note in passing that the *beauty* of these delicate and minute objects must not be considered *an end*—a purpose—in Nature. It is not so. The form is what it is because it *must be* so to serve the end for which the egg is formed. There is not a superfluous spine,

[1] A magnified image of the bee's sting was projected on the screen.
[2] A series of the eggs of butterflies were then shown, as were the objects successively referred to but not here reproduced.

not a useless petal in the floral egg, not an unneeded line of chasing in the decorated shell. It is shaped beautifully because its shape is needed. In short, it is Nature's method; the identification of beauty and use. But to resume. We may at this point continue our illustrations of the analytical power of moderate lenses by a beautiful instance. We are indebted to Albert Michael of the Linnean Society of England for a masterly treatise on a group of Acari, or *Mites*, known as the *Oribatidæ*. Many of these he has discovered. The one before you is a full grown Nymph, of what is known as a *palmicinctum*. It is deeply interesting as a form; but for us its interest is that it is minute, being only a millimetre in length. But it repeatedly casts the dorsal skin of the abdomen. Each skin is bordered by a row of exquisite scales; and then successive rows of these scales persist, forming a protection to the entire organism. Mark then that we not only reveal the general form of the Nymph, but the lens reveals the true structure of the scales, not enlargement merely, but detail. The egg of the organism, still more magnified, is also seen.

To vary our examples and still progress. We all know the appearance and structure of chalk. The minute Foraminifera have, by their accumulated tests, mainly built up its enormous masses. But there is another chalk known as Barbadoes earth; it is siliceous, and is ultimately composed of minute and beautiful skeletons such as those which, enormously magnified, you now see. These were the glassy envelopes which protected the living speck that dwelt within and built it. They are the minutest of the Radiolaria, which peopled in inconceivable multitudes the Tertiary oceans; and, as they died, their minute skeletons fell down in a continuous rain upon the ocean bed, and became cemented into solid rock, which geologic action has brought to the surface in Barbadoes, and many other parts of the earth. If a piece of this earth, the size of a bean, be boiled in dilute acid and washed, it will fall into powder, the ultimate grains of which are such forms as these which you see. The one before you is an instance of exquisite refinement of detail. The form from which the drawing of the magnified image was made was extremely small—a mere white speck in the strongest light upon a black ground. But you observe it is not a speck of form merely enlarged. It is not merely beauty of outline made bigger. But there is—as in the delicate group you now see—a perfect opening up of otherwise absolutely invisible details. We may strengthen this evidence in favour of the analytical power of our higher lenses, by one more *familiar* example, and then advance to the most striking illustration of this power which our most perfect and powerful lenses can afford. I fear that it may be taking too much for granted to assume that every one in an audience like this has seen a human flea! Most, however, will have a dim recollection or suggestive instinct as to its size in nature. Nothing striking is revealed by this amount of magnification excepting the existence of breathing pores, or spiracles along the scale armour of its body. But there is a trace of structure in the terminal ring of the exoskeleton which we cannot clearly define, and of which we may desire to know more. This can be done only by the use of far higher powers.

To effect this, we must carefully cut off this delicate structure, and so prepare it that we may employ upon it the first of a series of our highest powers. The result of that examination is given here.[1] You see that the whole organ has a distinct form and border, and that its carefully carved surface gives origin to wheel-like areolæ which form the bases of delicate hairs. The function of this organ is really unknown. It is known from its position as the *pygidium*; and from the extreme sensitiveness of the hairs to the slightest aërial movement may be a tactile organ warning of the approach of enemies, the eyes have no power to see. But we have not yet reached the ultimate accessible structure of this organ. If we place a portion of the surface under one of the finest of our most powerful lenses, this will be the result.[2] Now, without discussing the real optical or anatomical value of this result as it stands, what I desire to remind you of is (1) the natural size of the flea; (2) the increase of knowledge gained by its general enlargement; (3) the relation in size between the flea and its pygidium; and (4) the manner in which our lenses reveal its structure, not merely amplify its form. Now with these simple and yet needful preliminaries you will be able to follow me in a careful study of the least, the very lowliest and smallest, of all living things. It lies on the very verge of our present powers of optical aid, and what we know concerning it will convince you that we are prepared with competent skill to attack the problem of the life-histories of the smallest living forms. The group to which the subject of our present study belongs is the Bacteria. They are primarily staff-like organisms of extreme minuteness, but may be straight, or bent, or curved, or spiral, or twisted rods. This entire projection is drawn on glass, with *camera lucida*, each object being magnified 2000 diams., that is to say, four millions of times in area. Yet the entire drawing is made upon an area of not quite three inches in diameter and afterwards projected here. The objects therefore are all equally magnified, and their relative sizes may be seen. The giant of the series is known as *Spirillum volutans*; and you will see that the representative species given become less and less in size until we reach the smallest of all the definite forms and known to science as *Bacterium termo*.

Now within given limits this organism varies in size, but if a fair average be taken its size is such that 50,000,000 laid in order would only fill the one-hundredth of a cubic inch. Now the majority of these forms *move* with rapidity and grace in the fluids they inhabit. But how? by what means? By looking at the largest form of this group you will see that it is provided with two delicate fibres, one at each end. Ehrenberg and others strongly suspected their existence, and we were enabled, with more perfect lenses, to *demonstrate* their presence some twelve years ago. They are actually the swimming organs of this Spirillum. The fluid is lashed rhythmically by these fibres, and a spiral movement of the utmost grace results. Then do the intermediate forms that move also possess these flagella? and does this least form in nature, viz. *Bacterium termo*, accomplish its bounding and rebounding movements in the same way? Yes! by a series of resolute efforts, in using a new battery of lenses—the finest that at that time had ever been put into the hands of man—I was enabled to show in succession that each motile form of Bacterium up to *B. lineola* accomplished its movements by fibres or flagella; and that in the act of self-division, constantly taking place, a new fibre was drawn out for each half before separation.

(*To be continued.*)

[1] The pygidium of the flea, very highly magnified, was here shown.

[2] An illustration of the pygidium structure seen with 1/35th immersion was given.

THE PERIPATETIC METHOD OF INSTRUCTION IN SCIENCE AND ITS DEVELOPMENT[1]

THE object of this paper is to plead for the introduction of science as a part of the system of ordinary education in all public elementary schools, and to describe the method by which alone, in the opinion of the writer, it is possible that this should be accomplished. There is a general consensus of opinion that a far larger place than has hitherto been allowed in England should be assigned to science in our national system of education, as well as in our grammar-schools and Universities; but no strong conviction yet exists that a certain amount of strict and definite scientific training should be given to all the scholars in our public elementary schools as soon as they are prepared to receive it, which is practically found to be after they have passed the fourth standard. The extent of this claim for the introduction of science as a part of the ordinary curriculum of a public elementary school must be noted, in order that the worth and importance of the proposed method for securing thoroughly effective teaching may be understood.

The provision of special scholarships for those who possess exceptional intellectual power—admirable and necessary as this is—does not meet the broad claim I make. To furnish stages in the ladder by which a lad of mark, endowed with "five talents," may climb from the elementary school to the science college, is only to offer to the children of the poor opportunities to which they are justly entitled by virtue of the fact that genius, like truth, can neither be bought or sold, and is bestowed upon men entirely apart from any considerations connected with social rank and circumstances. But scholars of average ability, those who have no special endowments qualifying them for exceptional careers, ought not to be kept in ignorance of the fixed laws and the majestic marvels of the world in which they will have to labour, or to be deprived of the practical guidance, the intellectual interests, and the protection against coarse and degrading tastes, which scientific training is capable of bestowing upon

[1] Paper read at the Social Science Congress, September 22, by Henry W. Crosskey, LL.D., Chairman of the School Management Committee of the Birmingham School Board.

their lives. Only a few can rise to eminence; and it is an unmitigated misfortune for any lad to be encouraged to trust to his intellectual powers for his daily bread, unless he has a fair chance of becoming eminent; but all may possess the scientific knowledge which will give dignity to their daily toil; and the workshop itself may be ennobled.

Neither does the establishment of higher-grade Board schools, in which scientific instruction is given, meet the necessities of the case. The vexed and complicated questions involved in the general organisation of the very miscellaneous collection of schools now existing in England do not fall within the scope of this paper; but I find that many members of School Boards believe that all that is required for scientific instruction will be done when higher grade Board schools are opened; and, by means of examinations and scholarships, admission is brought within reach of a certain number of poor children unable to pay the fee.

Now, the grading of schools must educationally depend upon the time which the scholars can be expected to devote to education; and each grade of schools ought to have a curriculum, determined in its extent and balanced in its parts, according to the number of years which can be spent upon it. The public elementary school should furnish the completest possible education for those who can remain at school until the age of fourteen or fifteen; the higher-grade schools, which properly belong to the secondary system, should be adapted to the wants of scholars who can be retained a year or two longer. The higher-grade school cannot therefore supply the place of the public elementary school to the poor man, who is obliged to send his children to work at a comparatively early age; the number of subjects taught, and the relative number of hours given to them, will not be balanced in a way to suit his requirements.

My contention is that science ought not to be omitted from the educational training of the poorest of our people. The daily concern of the lives of the poor is with forces and materials upon which science throws the strongest light. Their work is bound up with scientific laws. Want of knowledge often means bad work or want of work; and even the spread of pestilence, disease, and death.

The establishment of higher-grade Board schools ought not, therefore, under any circumstances, to be permitted to lower the standard of education in public elementary schools. I speak emphatically on this point, because I believe that the working men of this country will need to take the most watchful heed lest they should be deprived of the education all their children are capable of receiving by the relegation of scientific subjects to schools placed beyond their reach by high fees, mitigated by only a small proportion of free scholarships.

Neither will the opening of technical schools suffice for the scientific instruction of our people. Technical schools cannot do their proper work if their students have had no preliminary training, and are unfamiliar with at least the elementary principles of physics. Lads who have grown into young men without being carried through any systematic and experimental course of scientific instruction will find it almost impossible, after they have left school, to prepare themselves properly for taking advantage of technical colleges, especially when, as among the working classes, their evenings only are at their own disposal.

In order that science may be effectively taught in public elementary schools, the following conditions must be observed:—

1. *It must be taught experimentally.*—Actual demonstration must accompany the lessons at every stage. At no point at which an experiment is possible must it be omitted. The minds of young lads of the type of those attending public elementary schools will be opened and enlarged by experimental demonstrations, but they will not be reached in any other way. Scholars may be able to pass examinations by getting up text-books; but unless they are made experimentally familiar with the principles of the science they are studying, their knowledge will hang as a dead weight upon their minds, impeding rather than quickening their intellectual activity. Those who have witnessed, as I have often done, the effect of an experimental lesson in science upon large classes of children, often drawn from the poorest of the poor, will not think this insistence upon a plenitude of experiments exaggerated. The demonstration thoroughly awakens their minds; their eyes glisten; there is a long-drawn "Ha" when the result accords with the theory which the teacher has expounded; and questions will soon show that they are not merely wondering at a conjuring trick, but that a new world, hidden within the world of machinery with which they are familiar through the daily avocations of their parents, is being revealed to them.

2. Science must not only be taught experimentally, but systematically and continuously. The "getting up" of some branch of science during three or four months as a "specific subject" for examination is of little use. "Passes" may be won; but no scientific training will be given.

From these considerations it directly follows that special science demonstrators must be appointed if our scholars are to receive a scientific training of any worth. It may be asked, cannot the work be done by one of the ordinary masters of the school? I am bound to reply that in my opinion—an opinion not lightly formed, but based on observations extending over a not inconsiderable area—it is absolutely impossible to obtain any training which can be called scientific, and prove of practical value, for the scholars of our public elementary schools, without the appointment of special science demonstrators.

In the first place, no man can be a good science demonstrator who does not devote to the work the greater part of his daily life. To perform experiments well is as much an art to be acquired by continuous study and practice as playing the piano. Fertility of resource, quickness of eye and hand, steadiness of mind, keenness of observation, are qualities essential to the demonstrator, which cannot be acquired without culture or retained without constant employment. The master of a school has many subjects to teach and many duties to discharge. He cannot, by any possibility, give any sufficient proportion of his time to the art and practice of scientific demonstration.

It may be said that an expert cannot be required for scholars of the age of those attending public elementary schools, and that any experiments they can understand can be easily performed by any ordinary teacher. Those who have studied any branch of physical science, however, will, I think, agree with me that no science can be well taught except by a man who has had a special scientific training; and that the simplest experiments are best performed and made the most intelligible by those capable of carrying on the more recondite and difficult investigations.

It is a great mistake to imagine that it is a light and easy matter to experiment before a class of scholars, such as those found in our Board schools. They are on the alert for any mistake; they are ready to raise the most curious and subtle doubts, and to ask the most perplexing questions. The only man capable of dealing with such a class of scholars is a man they are compelled to recognise as a master of the science he is teaching.

In the second place, even if the head master of a public elementary school were a scientific expert and managed to keep abreast with the advance of the scientific knowledge of his day, he would find it completely out of his power to act as a science demonstrator and to conduct the general work of his school. The preparation necessary for giving a good science lesson cannot be made without a larger expenditure of time than the proper management of his school will leave at his disposal. The mechanical arrangements for experiments often demand long-continued and anxious watchfulness and care. Every experiment ought to be tried over, before it is performed in the class, to avoid the risk of failure. The proper selection of experiments, as well as their performance, is in itself an art.

For the teaching of science in public elementary schools, therefore, these things are necessary: (1) sufficient apparatus, and of course a laboratory in which experiments can be prepared; and (2) a staff of special science demonstrators.

The expense of providing apparatus, building a laboratory, and supporting a science demonstrator at every single school in town and country, would be as enormous as unnecessary. By the general adoption, however, of what is known as the "peripatetic" method of instruction, all difficulties can be solved; and science can be effectively taught in every public elementary school. I do not think, indeed, that any other satisfactory method can be devised by which the whole of our elementary schools can be reached and the services of those trained scientific men, whose teaching of the elementary principles of science is alone to be relied upon, be secured for the great mass of our people. The peripatetic method has been adopted in Liverpool and Birmingham, and as I can testify so far as Birmingham is concerned, the results have been as satisfactory as remarkable.

The chief characteristics of this method are extremely simple:—

I. As regards "plant," it involves (1) the building of a laboratory in some central position; (2) the purchase of a stock of apparatus; (3) the provision of a small hand-cart by which boxes containing apparatus can be readily carried from school to school.

II. A special science demonstrator is appointed, with such assistants as the number of schools to be dealt with may require.

III. The duties of the science demonstrator are (1) to prepare a scheme of lessons and arrange the experiments for their illustration: in Birmingham, in the boys' departments, mechanics is taken as a "specific subject," and in some schools magnetism and electricity are added; in the girls' departments, domestic economy is taken, and animal physiology is in some cases added; (2) to visit the schools in succession, and give at each school a lesson profusely illustrated by experiments, the requisite apparatus being brought by the hand-cart from the central laboratory.

IV. The regular staff of the school assists the demonstrator, and is assisted by him in the following ways:—

(1) A teacher on the staff of the school is present at every demonstration, and is thus prepared to enforce and continue its lessons in the intervals elapsing between the demonstrator's visits.

(2) The scholars have opportunity given them during school hours to write answers to questions set by the demonstrator, who examines their papers.

In Birmingham a "demonstration" is given in each department once a fortnight. It would be, however, a great improvement if the demonstrator or one of his staff could visit each school once during every week. The science staff consists of a chief demonstrator (Mr. W. Jerome Harrison, F.G.S., whose services deserve the warmest acknowledgment), three assistant demonstrators, who assist in giving lessons at the schools, and a junior laboratory assistant. Two youths are employed to work the hand-cart. The whole amount of salary paid to this staff amounts to 750*l.* per annum.

Scientific instruction is given by this method in thirty boys' schools and thirty girls' schools, containing about 32,000 scholars, the numbers in the classes and the specific subjects taken being:—

Mechanics	2400 Boys
Magnetism and Electricity	300 ,,
Domestic Economy	1800 Girls
Animal Physiology	100 ,,

Objections may possibly be taken to this system in the following directions:—

I. *Its cost.*—It being granted, however, that thorough and systematic scientific instruction ought to be introduced into elementary schools, the peripatetic method is the very cheapest that can be devised. One set of apparatus serves for many schools, and one laboratory suffices for the preparation of the experiments. The services of the staff are utilised to the utmost; and the amount of salary to be charged against each school is trifling. Supposing twenty schools in a town or neighbouring villages to be grouped together, the system might be worked at a very slight expense to each. The investment of capital required would be less than 1000*l.*, viz.:—

Building of Central Laboratory[1]	£700
Apparatus	300
	£1000

The annual working expenses would be—

Salaries of science demonstrator and assistant	£400
Waste of chemicals, renewal of apparatus, &c.	50
Expense of moving apparatus from laboratory to school	50
	£500

Ample provision could be made at this cost for twenty schools, each having accommodation for 300 or 400 children, *i.e.* each of the associated schools could obtain, for about 25*l.* a year, thoroughly good experimental instruction for all scholars who have passed the fourth standard.

II. It may be asked whether, in the short time that can be allowed for any specific subject, it is possible to obtain results of sufficient educational worth to justify the expenditure of labour, thought, and money I am advocating. As a reply to this objection, I can point without fear to the results actually attained in Birmingham; an hour to an hour and a half a week being all the time which has been spared for science, including the fortnightly demonstration, the recapitulation, and preparation of exercises. The teaching being experimental, an impres- is made upon the minds of the scholars which can neither be equalled or measured by the effects of ordinary class teaching, lecturing, or book work. The scholars are induced to think, and read, and prepare models of machines and drawings out of school hours; and during school hours they are found to apply themselves with a will to their scientific exercises. Prof. Poynting (of Mason College) has examined a large number of boys competing for a scholarship, and reported to the Board that "the boys showed that they had seen and understood the experiments which they described, that they had been taught to reason for themselves upon them, and that they were not merely using forms of words which they had learned without attaching physical ideas to them." Specimens of the models made by the children, their drawings, and examination papers, have been exhibited at the International Health Exhibition, of which the subjoined account is given in the *School Board Chronicle* (August 9, 1884):—"The cabinet of machines and models and copies of the science apparatus used by the demonstrators in their experiments is well worthy of a visit. It shows the extent and nature of the interest which the children take in this practical form of education. Most of the models have been made by the children at their homes, and often with very inferior tools. One lad has a copy of the Chinese windlass, another makes a little pile engine, and a third illustrates the inclined plane, a fourth the mariner's compass, and so on through a great variety of objects, until a very tolerable little collection of rough but serviceable apparatus has been brought. In cases extending the length of one of the walls of the room is a collection of specimen papers and drawings, prepared at the demonstrator's fortnightly examination of the results of his preceding lesson, and no further justification of the system than these papers can be needed."

In comparing these models and papers with others, it must be remembered that the Birmingham work was not done in any "higher-grade" institutions, with high fees and picked scholars, but indicates the kind of scientific training that may be given by the help of the peripatetic method in any public elementary school.

III. Great anxiety is felt by many lest the introduction of science into elementary schools should result in mere "cram"; and a number of hard technical words be repeated by rote to be forgotten as soon as school is left. It is not unusual to hear a laugh raised by the quotation of some technical word from an examination paper, as though its use reduced the system to an absurdity. Scientific facts are, however, most clearly expressed in scientific language. Even young scholars gain by knowing the *right words* by which physical facts and laws are described; and their intellects are bemuddled by vague expressions. The employment of scientific words is no proof of "cram." I admit, as a matter of course, that the attempt to teach science without demonstrating experimentally every fact and law, must result in cramming of the worst description; but *experimental teaching gives the death-blow to cram.*

IV. Will not, however, it is sometimes asked, the introduction of this system of scientific teaching interfere with the progress of the children in writing, reading, and arithmetic? Will not the elements of ordinary education be neglected because of the attention demanded for such scientific subjects as mechanics, magnetism, and electricity? On the contrary, it is found as a matter of fact, that the intellectual life of the school is quickened in every direction by the study of science. The scholars find that the "three R's" are not dull, dry, and abstract pursuits, but keys to a world of new marvels and interests. The schools under the Birmingham Board in which there is the keenest interest in science are certain to prove the schools in which the ordinary work is best done. Since 1880, when the science demonstrator was first appointed, the percentage of passes in the "three R's" has steadily increased, as well as the number of passes in specific subjects.

Year	Number of passes in specific subjects	Percentage of passes in the "three R's"
1880	841	84·7
1881	1724	88·4
1882	3114	92·6
1883 { New Code with higher requirements }	3150	89·6

[1] The Birmingham laboratory cost (with fittings) 1450*l.*, but it has a lecture-room and private room for demonstrator attached.

Various causes have, no doubt, contributed to this result; but the proof is positive that the introduction of science *has not interfered*, to say the least, with elementary education in the "three R's."

V. On the first introduction of the system there may be a certain amount of antagonistic feeling aroused amongst some head masters and mistresses. In Birmingham this was indeed to some small extent the case. Some head teachers feared that the demonstrator would prove a new inspector, who, having to discharge duties as a teacher, might unduly interfere with their own functions, and that some conflict of authority might occur. To the best of my knowledge, however, this feeling has entirely disappeared. The only complaints which I hear as Chairman of the School Management Committee, are when the experimental lessons are omitted at any school through any stress of examination work or accidental circumstance. The masters find that the science demonstrators render them valuable assistance and do a work which it is out of their own power to accomplish.

In order to apply the severest test to the peripatetic system, I applied to the head master of a large school, situated in one of the very poorest districts in Birmingham, and attended by children whose social surroundings are, as a rule, almost as unfavourable to intellectual development as they can possibly be. The school has accommodation for 416 boys, and an average attendance of about 350, 414 being sometimes present during the week.

The reply of the head master to my request that he would inform me of the results of the science teaching in his school, lifts the whole question out of the region of controversy.

Dartmouth Street Boys' Board School,
Birmingham, September 9, 1884.

Rev. Sir,—In reply to yours of this morning, I beg to make the following remarks:—

The results from the science lessons given in this school are very gratifying. I have seen results in a variety of ways both in and out of school.

The interest taken in these lessons, both by parents and boys, is surprising. Many a mother has, to my frequent knowledge, inconvenienced herself in her domestic duties on certain days when we have sent word for her boy to be present, as the science demonstrator was expected that morning. The day is well remembered by most of them, and eagerly looked forward to. The attendance in the uppermost class is wonderfully increased on the mornings these lessons are given.

The results in other subjects in those standards where science is taught are none the less satisfactory. A greater intelligence and thought are quickly discovered when we are dealing with the other subjects.

Teachers are more encouraged when brighter material to work with is placed in their hands.

Other important subjects have impressed me very much, viz. the desire of the boys after leaving school to continue to study some science subject at some of our science classes.

Older brothers, too, have been induced to go to science classes through seeing the growth of knowledge in those much younger than themselves.

Many persons who have reason to come in contact with the boys after leaving school, have expressed themselves in tones of great regret that such instruction was not given when they attended school.

I remain, Rev. Sir,
Your obedient servant,
Rev. Dr. Crosskey. T. H. PURCELL

As a development of the systematic and experimental system of science training I have described—a system only rendered possible of adoption by the employment of the peripatetic method—a new kind of Board school has been opened in Birmingham, for the purpose of enabling the scientific work commenced in the elementary school to be continued by the more advanced scholars before they enter upon their respective employments in workshops and factories.

The arrangements of the peripatetic system will suffice until the sixth standard is passed; but special provision must be made for those lads who can remain a year or two longer at school, and whose future employments render the extension of their scientific training desirable. A large proportion of those who pass the sixth standard are obliged to earn their livings at once; for these various evening classes are available. But a certain number of working men can, by an effort, manage to exempt their children from toil, say for an extra two years.

The question therefore arises whether special provision cannot be made for scholars who must ultimately earn their living as working men, but whose parents can afford to keep them at school for two years after they have passed the sixth standard?

It is evident that for such scholars increased facilities for scientific study will have a peculiar, indeed almost an incalculable, importance.

They have been well grounded in the first principles of science and familiarised with the management of apparatus and the conduct of experiments during their school career. Their work in life will be largely increased, not only in pecuniary and mechanical, but in intellectual and moral value, by scientific knowledge.

To meet the wants of this class, a school has been opened as an experiment, in New Bridge Street, Birmingham, in premises belonging to the Chairman of the Board (Mr. George Dixon), who, at the cost of more than 2000*l.*, has adapted them for the purpose, and placed them rent free at the service of the Board.

The characteristics of this school are the following:—

I. It is especially intended for scholars who will have to become working men, but whose parents can keep them at school after they have passed the sixth standard, and the fee (3*d.* a week) is adapted to their means.

II. While a seventh standard school under the Code, the instruction given is largely scientific and technical; and a special staff of trained scientific men has been appointed. There is a special master for chemistry and metallurgy; another master for mechanics and physics; a drawing master; and a mathematical master; a highly qualified scientific man being placed at the head. Workshop instruction is provided, and includes a knowledge of the chief wood tools, and the properties of materials, while it supplements the mechanical drawing of the schoolroom, and is an aid to the study of theoretical mechanics.

III. The course of instruction is arranged to extend over two years. In the first year the scholars take ordinary standard work, together with mathematics, mechanics, drawing, chemistry, and workshop practice.

In the second year the study of mathematics will be continued, but it is intended that the scholars shall then specialise their studies in one of the following groups: (1) Chemistry and Metallurgy. (2) Mechanics and Machine Drawing. (3) Physics and Geometry.

The peculiarity of this scheme is that it is not an attempt to benefit a few picked scholars or to provide a higher-grade school for those able to pay high fees, but that it is a continuation of the science training given by means of the peripatetic method in every ordinary elementary school under the Board.

It has already been made evident that a large capacity for scientific investigation—amounting, I believe, almost to a special genius for the study of science—exists among our English people, which has never yet received its full and fair development. The country is undoubtedly awakening to the necessity of making better provision for the study of science, in order that our manufacturers may hold their own in the markets of the world. Other and higher blessings will follow in its train. Labour, in being made intelligent, will cease to be so loveless as it often is, and the lives of toiling thousands will be filled with larger interests, guided by finer tastes, and enriched with nobler joys.

THE ASSOCIATION OF GERMAN NATURALISTS AND PHYSICIANS

THE annual gathering of this influential Society was held this year at Magdeburg during the week ending September 23, simultaneously with the yearly meetings of the German Botanical and Meteorological Associations. The proceedings were opened by the President, Dr. Gaehde, whose address was followed with a few appropriate remarks by Prof. Hochheim on the services rendered to science by Guericke and other distinguished physicists.

The formal work of the meeting was opened with a paper by Prof. Rosenbach of Göttingen, on the microscopic organisms present in festering wounds. After a brief reference to the discoveries of Koch and Ogston, the author dwelt upon his own investigations, by which he claims to have proved that all purulent matter is primarily due to minute animal organisms. The most widespread of these germs is a yellow micrococcus, which, owing to its bunchy disposition when seen under the microscope, he has called the "grape coccus." It displays great vitality, and even after twenty or thirty years may give rise to rheumatic affections of the bones and joints. Another common species is the "chain coccus," consisting of small granular bodies strung together and presenting the appearance of chains or wreaths (Pasteur's "*chapelets*").

Owing to the colonial policy at present agitating German political and commercial circles, great interest was taken in a paper by the African explorer, Gerhard Rohlfs, on the position of Africa with regard to Germany. It contained an historic sketch of the relations of Germany with the Dark Continent, recommended the establishment of factories or trading stations in favourable places, but uttered a warning note against any premature scheme of emigration to Africa.

The second general session opened with a memoir by Prof. Braun on the Island of Yesso and its inhabitants, dealing with its geographical features, the character and social usages of its Aino aborigines, and concluding with an expression of confident assurance that sooner or later Yesso must be drawn within the sphere of European culture. Some remarks followed by Dr. Huyssen of Halle on the deep borings in the North German lowlands. A sketch was given of the borings executed since 1868 at the expense of the Prussian Government, with special reference to the results obtained in the gypsum formations at Sperenberg, twenty miles south of Berlin. Here a bed of rock-salt was met at a depth of 283 feet, through which the boring was continued down to 4051⅔ feet without reaching the bottom of the deposit. An account was given of the new method of boring, by which it became possible to sink a shaft to a depth corresponding to the height of the Brocken in the Hartz Mountains. The thermometric observations made in connection with these operations were stated to have fully confirmed previous views regarding the increased rate of temperature from the surface downwards.

Universal attention was attracted by the essay of Dr. Kirchhoff of Halle on "Darwinism and Racial Evolution," in which it was argued that the physical development of peoples was intimately dependent on the natural conditions of their respective surroundings. The inhabitants of northern lands are noted for a preponderance of the pulmonary functions; those of hot, moist, tropical regions for a more marked activity of the liver. Thus the strongest lungs prevail amongst the Mexicans, Peruvians, and Tibetans, who occupy the three highest plateaus on the surface of the globe. That adaptation to the environment is a question, not of "predestined harmony," but of natural selection, is shown by the evolution of the negro, the most perfect type of tropical man, who is found only in the Dark Continent. The daily pursuits of a people are, on the other hand, constantly evoking special organic peculiarities. This is shown most clearly in the keen sense of smell, sight, and hearing observed in all hunting and pastoral tribes of the highlands and steppe-lands, as well as in the sense of locality, and the surprising physical endurance under hunger, thirst, and other privations. Sexual selection, again, operates in the development of the body—head, hair, beard, and the like; in the style of dress and love of ornament; and lastly, in the formation of the national character, valour and ferocity being mainly conditioned in the savage, the economic and domestic virtues in civilised man, by the choice of partners in life, and the rejection of unqualified wooers in the "matrimonial market." But, apart from this consideration, the principle of selection prevails in the moral as well as in the physical order. As mankind pressed northwards, irrepressible spirits alone could sustain life under the depressing influences of bleak, Arctic surroundings. Hence the remarkably cheerful temperament of the Eskimo, who are also bred to peaceful habits, for peacefully-disposed families alone could dwell under a common roof, as the Eskimo are fain to do in the total absence of fuel. Through over-population the Chinese have become the most frugal and industrious of peoples, in recent times emigrating to foreign lands and crowding out all more indolent or pretentious races. In the international struggle for existence physical and moral superiority must always tell in the long run.

Even greater interest was taken in Prof. Finkler's paper, read with demonstrations on the bacillus of cholera and its culture. An outbreak of this epidemic last July at Bonn gave Prof. Finkler and Dr. Prior an opportunity of applying Koch's method to the study of the comma-shaped bacillus, which showed a remarkable resemblance to that of Asiatic cholera cultivated by Koch. It was found associated with large masses of the spiral-shaped organism, but with no other germ of specific appearance. These forms could not be detected in preparations of normal or any other pathological excreta under the same method of treatment. But after several failures a comma bacillus was obtained, which in its nourishment, period of evolution, and temperature behaved exactly like corresponding cultures obtained by Koch from true cholera. Still differences occurred in respect of the successive stages of evolution, which inferentially affects the question of the permanent form of the germs. After some time they become thicker, and assume somewhat the form of a whetstone, while at both extremities spore-like forms make their appearance, and take the shape of spore-bearers. Both spores are presently extruded from the spore-bearers, and begin to crawl about under the microscope. They assume the form first of straight, then of crooked rods, which develop into spirals of diverse shape, length, and curvature. Becoming thicker and swollen, these spirals in their final evolution seem to consist exclusively of small comma bacilli. But whereas the comma of Asiatic cholera, at least according to Koch's investigations, develops no permanent form, these acquire a stability in the spore state capable of resisting the process of putrefaction. Their behaviour, however, when being desiccated or subjected to chemical agents has not yet been tested by Prof. Finkler. Between the prepared specimens of cholera nostras and true cholera bacilli exhibited under the microscope no optical difference could be detected. Owing to the attitude of most German physicians, who regard it as a patriotic duty to hold Koch's doctrine as unassailable, while the German scientific journals persistently ignore the objections urged by eminent foreign investigators against the theory, Prof. Finkler's statements naturally excited considerable sensation, giving rise to an animated discussion, without however arriving at any positive results. In any case a severe blow was given to the assumption of Koch's infallibility, although Prof. Finkler and Dr. Prior have so far failed to determine the true pathogenetic and pathognostic functions of their cholera nostras comma bacillus, as completely as Koch has for his Asiatic cholera comma bacillus.

In the Section devoted to Mathematics, Astronomy, and Geodesy, Dr. Spörer of Potsdam discoursed on the determination of the elements of rotation in the sun, and on the origin of the solar spots. The theory was advocated of currents setting steadily towards the surface of the sun both from within and without.

Discussing the subject of comets' tails, Dr. A. Marcuse of Berlin assumed that the sun acted like an electro-magnet, and that the normal tails of comets consisted of diamagnetic material (carburets of hydrogen), whereas the abnormal tails, that is, those directed towards the sun, consisted of paramagnetic materials, such as iron.

In the Physical Section papers were read by Prof. Knoblauch of Halle on two fresh attempts to determine the angle of polarisation of metals; by Prof. Overbeck of Halle on galvanic polarisation; by Prof. Ostwald on galvanic resistance, dividing the acids in relation to the velocity of electrolytico-chemical reaction into three sharply separated groups according as they are uni-, bi-, or tri-basic; by Prof. Spörer on eruptions breaking through the nucleus of a solar spot; and by Prof. Recknagel on atmospheric resistance, arguing against Lössel that it increases with the size of the plates when these are circular.

The Meteorological Section, coinciding with the annual meeting of the German Meteorological Society under the presidency of Prof. Neumayer, was unusually well attended. Amongst the foreign honorary members elected on this occasion were Prof. W. Ferrel of Washington, Prof. H. Mohn of Christiania, and Prof. H. Wild of St. Petersburg. In his address on the development of meteorology and its importance to the State and society, Prof. Neumayer dwelt especially on the influence of Dove, Sabine, and other investigators, as well as of the various Polar expeditions and of the British Association on the general advancement of meteorological studies. In a second discourse he referred to the importance of synoptic studies in the South Atlantic Ocean, pointing to the results already obtained from observations taken in high southern latitudes, and urging the necessity of further investigation in the same regions.

Dr. Köppen of Hamburg followed with a paper on the principles determining the distribution of meteorological stations. Discussing the question of atmospheric electricity and lightning, Dr. E. Hoppe of Hamburg argued that the ascent of a warm atmospheric current must give rise to a thunderstorm as soon as it acquires sufficient velocity to prevent the equilibrium of the electric current generated through the condensation produced by friction. Prof. Kiessling of Hamburg made some remarks on the diffraction colours in artificially-produced fog and their connection with the recent crepuscular phenomena. In the same department papers were submitted by Dr. Münter of Herford, on the cause of winds, and by Dr. Köppen of Hamburg, on barometric disturbances during storms.

In the Chemical Section the chief speakers were: Dr. Frank of Charlottenburg, on the past technical development of the alkali works at Stassfurt, where, in July 1882, 20,000,000 cwts. of carnallite were consumed in the preparation of chloride of potassium; Prof. Poleck and Dr. T. Schiff of Breslau, on the essential oil of *Sassafras officinalis*, Neer; Prof. Poleck, on talapin; Dr. Arrhenius, on the conductive force of the electrolyte; Prof. C. Willörodt of Friburg (Baden), a contribution to the study of acetonbromoform and acetonchloroform; Prof. E. Lippmann, on a new method of representing oxygenous compounds; Dr. Leuckart of Göttingen, on a synthesis of aromatic monocarbon acids, dealing with the reciprocal action of aromatic carburets of hydrogen and cyanates in the presence of chloride of aluminium.

In the Geological and Mineralogical Section papers were read by Prof. Lossen of Berlin on the peculiar features of the geology of the Hartz Mountains; by Prof. von Fritsch of Halle on the Cretaceous floras of the Hartz; by Prof. Nehring on the diluvial fauna of the province of Sachsen and conterminous districts; by Dr. Wahnschaffe of Berlin on the Quaternary formations in the neighbourhood of Magdeburg; by Engineer Petsch of Aschersleben on the subsidence of underground waters during the process of freezing.

In the Botanical Section Prof. E. C. Hansen of Copenhagen described some new researches on certain fungi of vinous fermentation found in cow-dung and on sweet succulent fruits; A. Zimmermann, on the action of the optical elastic ellipsoid of vegetable tissues in the process of expansion: from a study of the tissues of *Nitella flexilis* and some other plants, the author concluded against Noegeli that in optical respects no fundamental contrast exists between organic and inorganic substances; W. Detmer on the formation of muriatic acid in plants; Prof. Soraner on the action of artificial freezing, describing the conduct of various vegetable tissues under the freezing process; Dr. Kaiser on the results of the determination of fossil leafy plants.

In the Section for Zoology and Comparative Anatomy, Prof. Landois of Münster spoke on the development of the shell of certain birds' eggs; Dr. H. F. Kessler of Cassel, on the evolution and life-history of the blood parasite, *Schizoneura lanigera*, Hausm.; Prof. Nehring of Berlin, on the skull and skeleton of the Peruvian dogs from the Necropolis of Ancon, with remarks on their origin: on the ground of his comparative studies, the author inferred that these dogs must have sprung from some variety of the North American wolf (*Lupus occidentalis*); Dr. Müllendorf of Berlin, on the importance of the formic acid found in honey: when closing the cells of the honeycomb, the bees mix the honey with formic acid in order to give it greater consistency; Prof. Leuckart of Leipzig, on a new species of Nematode found in the body of *Hylobius pici*, 3 mm. long, 1 mm. thick, and named *Allantiema mirabile*; Prof. W. Blasius, on some fresh data in connection with the remains of *Alca impennis*, Linn.

The excursions with which the proceedings were diversified included visits to the model Meteorological Observatory of the Magdeburg Zeitung, to the neighbouring chemical works of Stassfurt, to the University of Halle, and to the Hartz Mountains.

It was announced that the Association would hold its next annual meeting at Strasburg.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, No. 3, September 1884.—Synchronous-multiplex telegraphy in actual practice, by Prof. Edwin J. Houston (illustrated).—An extraordinary experiment in synchronous-multiplex telegraphy, by Prof. Edwin J. Houston.—On the application of electricity as an illuminating agent in astronomical observatories, by W. S. Franks.—A metastatic heat regulator, by N. A. Randolph, M.D. (one figure).—The drying of gunpowder magazines, by Prof. C. E. Munroe, U.S.N.A.—On an explanation of Hall's phenomenon, by Shelford Bidwell, M.A., LL.B. (table).—Instruction in mechanical engineering, by Prof. R. H. Thurston.—Report on the trial of the "City of Fall River," by J. E. Sague, M.E., and J. B. Adger, M.E. (concluded from p. 115) (tables and diagrams).—Report of the Board of Experts on Street-paving (tables).—Surveys for the future water-supply of Philadelphia, by Rupert Hering, C.E. (tables).—Methods in physical astronomy.—Solar motor and solar temperature.—Hirn's actinometer.—Soap-roots.—Aluminium and aluminium-bronze.—Palmieri's atmospheric electricity.—New electro-magnet.—Tanning by electricity.—Gases in steel.—The volcanic ashes of Krakatoa.—Papal Observatory.—Origin of volcanic activity.—Balloon photography.

Verhandlungen des naturhistorischen Vereins der Rheinlande und Westfalens, January-June.—Report on the proceedings of the Society during the year 1883.—On the recent chalk and diluvium formations of the Mülheim district, by Dr. Deicke.—On the disposition of the stratified rocks and lias in the neighbourhood of Herford, by H. Monke.—Report on the fossils of the greensand rocks in the district of Aix-la-Chapelle, by J. Böhm.—On the fishes, crustaceans, and flora of the Upper Chalk system in Westphalia, by Dr. Marck.—On the digestive organs of the spider, by Prof. Bertkau.—On the human skull found associated with the mammoth, rhinoceros, and reindeer in the loess of Podbaba near Prague, by Prof. Schaffhausen.—On some fossil remains from the Devonian rocks of Eifel, by Prof. Schlüter.—A contribution to the physiology and anatomy of *Dasypoda hirtipes* (two plates), by Dr. Hermann Müller.—On the diorite of the Upper Ruhr Valley and its association with the argillaceous schist of the same district, by Dr. A. Schenck.—On the causes of the great oscillations and disturbances in the crust of the earth, by F. F. von Dücker.—On the occurrence of fossil wood in the region of the Westphalian Coal-Measures, by W. Wedekind.—On the mutual relations of the Middle Eocene formations of Monte Postale, Ronca, and San Giovanni Ilarione, by Dr. H. Rauff.

Rendiconti del R. Istituto Lombardo, July 31.—Some reflections on the proposed laws for regulating the administration of public and private lunatic asylums in Italy, by Dr. C. Zucchi.—Various researches on the Bacillus of tuberculosis, by Prof. Giuseppe Sormani.—Description of a continuous registrar of electric energy transmitted at any given point of a circuit, by Prof. R. Ferrini.—On the geometrical surface of the third order, by Prof. E. Bertini.—Remarks on the Turin Gloss on the Institutions and Paraphrase of Pseudotheophilus, by Prof. C. Ferrini.—Meteorological observations made at the Brera Observatory, Milan, during the month of July 1884.

Rivista Scientifico-Industriale, August 15.—Results of experiments on the variations of electric resistance of argentan wire subject to tension, by Dr. Sebastiano L. Angelini.—Experiments on the compressibility of fluids, and especially of water, by Prof. Pagliani and Dr. S. Vicentini.—Observations on the struggle for existence between *Staphylinus olens* and *Lumbricus agricola*, by Silvio Calloni.

August 30.—Description of a universal anemometrograph (wind-gauge) recently invented by Prof. Michele Cagnassi.—Remarks on an elementary demonstration relating to the theory of the potential, by Giuseppe Vanni.—Remarks on the variations in the electric resistance of solid and pure metal wires under changes of temperature, by Prof. Angelo Emo.

Bulletin de la Société des Naturalistes de Moscou, 1883, No. 4.—On the seeming anomalies in the structure of the great comet of 1744, by Th. Bredichin (in French), with plates. It appears from calculations, illustrated by a plate, that the strips observed on this comet correspond to the "synchronal" curves of the author deduced in the hypothesis of repulsive force.—Some remarks on comets, by the same. The initial speed of their appendages towards the sun is approximately deduced at 2000 m. per second.—On the tail of the first type of the comet 1858 V., by A. Sokoloff (in French), being a calculation of "syndynamic" curves according to Bredichin's method.—On *Cæsona pinitorquum*, A. Br., by Ed. Kern (in German), with 4 plates.—Remarks on the geological map of the Vetluga region, by H. Trautschold.—A new Pleurotoma (*Renardii*) from the Miocene of Italy, by De Gregorio.—A new demonstration of the theorem of Lambert, by N. Joukovsky (in French); it is based on the formula of variation of action.—Materials for the geology of the Crimea, by W. Sokoloff (in Russian), being notes on the Jurassic and Neocomian deposits in the neighbourhood of Simferopol.—On the recent work of the United States geologists, by H. Trautschold.—Letter from Dr. Regel, from Tashkend.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 13.—M. Rolland, President, in the chair.—Note on the theory of the figure of the earth, by M. F. Tisserand.—On the decomposition of the oxide of copper by heat, by MM. Debray and Joannis.—Note on the sulphuret of carbon, and the application of a solution of this substance in water to the treatment of the vine attacked by phylloxera, by M. Eug. Peligot. Its solubility in water is shown to be considerably greater than that recently determined by M. Ckiandi. At the ordinary temperature water dissolves 3·5 c.c. per litre, or 4·52 grm., its density being 1·293. Its antiseptic properties have also been fully confirmed by the further investigations of M. Pasteur, who anticipates that it will become the most efficacious of all antiseptics, it being also the cheapest, costing only a few centimes per litre. It is, moreover, the best known insecticide, and has already rendered great services in the destruction of phylloxera. At present 30,000 hectares of vineyards are yearly treated with over four million kilogrammes of the sulphuret of carbon with excellent results. When applied in the form of a sulphocarbonate of potassium it has a double action, the sulphuret killing the insect, and the potassa, an essentially fertilising element, enriching the soil.—On the nitrates present in plants (continued), by MM. Berthelot and André. Their distribution during the various periods of vegetable growth, and their relation to the total proportion of the fundamental elements, potassium and nitre, contained simultaneously in the leaves, stem, root, and flower, are discussed by the authors.—Observations made at the Observatory of Marseilles during the recent total eclipse of the moon, by MM. Stéphan and Borelly. The occultations of several stars contained in the list supplied for the purpose by M. Struve of the Pulkowa Observatory were observed.—Note on the map of the erratic phenomena and ancient glaciers on the northern slope of the Swiss Alps and of the Mont Blanc range, by M. Alph. Favre. This map, drawn to the scale of 1 : 250,000, indicates the extreme development of the old glaciers, and, as far as possible, the glacial drift, erratic boulders, and moraines deposited in this region during the period of glaciation. The glacier basins, marked in different colours, by no means coincide with the present hydrographic systems of the country. Six great glaciers are enumerated: that of the Arve, stretching from Mont Blanc to Lake Bourget; that of the Rhone, running from Furca in one direction to Lyons, in another to the Rhine near Laufenburg; that of the Aar, extending from the glaciers of that name to Berne; that of the Reuss, issuing from Mont Saint-Gothard and terminating near the Rhine; that of the Limmat, stretching from the Glaris highlands to the Rhine; lastly, the vast glacier of the Rhine issuing from the Grisons, traversing Suabia, and terminating near Sigmaringen on the left bank of the Danube.—Observations made at the Observatory of Marseilles of the planets 240 and 241, and of Max Wolf's new comet, by M. Stéphan.—Description of a new galvanometer with astatic needles (one illustration), by M. E. Ducretet.—Note on the mechanical dislocation of the persistent images left on the retina of the eye after gazing on highly illuminated bodies (one illustration), by M. F. P. Le Roux.—Note on a preparation of trichlorurretted camphor, by M. Cazeneuve.—Description of the first larva from the egg of *Epicauta verticalis*, by M. H. Beauregard.—Note on two new species of simple Ascidians (family of the Phallusiadeæ), by M. Roule.—On the anatomical structure of *Anchynia rubra*, by M. N. Wagner.—Account of a new insect of the genus Phylloxera (*Phylloxera salicis*, Lichtenstein), by M. J. Lichtenstein.—Note on a meteor recently observed near Royan, by M. Chapel.—Remarks on M. Paul Venukoff's new work "On the Deposits of Devonian Formation in Russia," by M. Daubrée.—Note on a block of pumice found on April 13, fifteen miles off the Madagascar coast, in 14° 35′ S. lat., 48° 2′ E. long., and supposed to have come from the Krakatoa eruption, by M. Alph. Milne-Edwards.

STOCKHOLM

Society of Natural Sciences, September 20.—Prof. Sandahls, President, in the chair.—Dr. Wille gave an account of his researches this summer at the zoologico-botanic station established at Dr. Regnell's expense at Kristineberg, in the province of Bohus, as to the mechanical power of the higher Algæ to endure strain, and thereby resist the swell of the sea. He described his method, and gave an account of the strain which strips of Algæ of certain lengths and thicknesses could bear. He found that they possessed a very high degree of resistance and elasticity, but that when the weight was removed they retained some of the additional length caused by the strain. As might be expected, the power of resistance was greater in the lower than the upper parts, as the former suffer a far greater strain than the latter from the swell of the sea. He further referred to the anatomical causes of this, which were due to the circumstance that the specific mechanical cells which had to resist the strain were preferably developed in the lower parts, and to the fact that, as the plant grew, special organs of strengthening—they might be called moorings—were successively dropped to the bottom from the sides of the Algæ, and in some cases even developed through the membrane downwards. The lecture was illustrated by means of drawings.—Dr. Thedenius exhibited a specimen of the moss *Riccia natans*, taken by him the the same day at Sundbyberg, the only spot in Scandinavia where it grows. He also exhibited a hitherto unknown hybrid of *Tragopogon porrifolius* and *T. minor*, which had grown in his garden this summer, where both grew, and referred to the hybrid of *T. porrifolius* and *T. pratensis* found some time ago at Karlskrona. He also exhibited *Bryonia dioica*, a species never before grown in Sweden, which he had found in his garden.—The Secretary referred to an article forwarded to the Society on the East Indian plant *Abrus precatorius*, according to which a particular variety of Bacillus had been discovered in the poisonous infusion of its seed, which demonstrated that infectious diseases could be transmitted by plants, and pointed out that Dr. Widmark, a Swedish botanist, had recently shown that the Bacteria were not originally in the infusion in question, but that it only served to sustain the Bacteria which had immigrated thither from the air. He concluded by mentioning the well-known but inexplicable phenomenon of *Pinguicula vulgaris* having the effect of curdling milk when the vessels containing the latter had been rubbed with the butterwort, which was most probably due to microbes.

Botanical Society, September 27.—Prof. V. B. Wittrock, President, in the chair.—The meeting was the first one of the winter term.—On the diseases of cultivated plants in Sweden, by Herr J. Eriksson.—On the geographical extension of some rare Swedish Phanerogams, by the President.—On the 13th and 14th fasciculæ of the work "Algæ aquæ dulcis, exsiccatæ, quas distribuerunt Veit Wittrock et Otto Nordstedt," which had recently appeared, by the same.

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