THURSDAY, DECEMBER 3, 1891.

## FIELD GEOLOGY.

*Outlines of Field Geology.* By Sir Archibald Geikie, F.R.S. (London: Macmillan and Co., 1891.)

GEOLOGISTS, we are sometimes told, are a combative race. Geologists may fearlessly allow that the impeachment has a spice of truth in it. They may take comfort when they reflect that no serious consequences have ever followed from this tendency, in spite of the facilities which the formidable weapons they carry with them offer for pushing it to an extreme. Their healthy out-door life prompts banter, and the passes are apt to be so quick and keen that the uninitiated may be pardoned if they think the buttons are off the foils.

The meetings of the Geological Society have witnessed many a sharp passage of arms. It may be permissible to recall one. A well-known member of the brotherhood, safe long ago among the majority, of large and varied experience, was indulging in just a little brag about the broad areas he had surveyed. The retort came sharp and quick from one whose quips and cranks are now alas heard no more: "Where are your maps?" And the contemptuous answer was, that the chief requisites for geological mapping were a stout pair of legs and sound wind. There were elements of truth in this lively sparring, despite its extravagance.

It is a truism that need hardly be repeated, that geology cannot be learned without out-door work, and geological excursions are a necessary item in all geological teaching. But what do they amount to? There is a leader who knows the country well. He selects a line along which sections follow one another in close succession. The exposures are so plentiful and near together that even the beginner realizes without difficulty the order in which the several rock-groups follow one above the other, and there are ample opportunities for mastering their lithological character and fossil contents. A longitudinal section is readily constructed, and figures with more or less of misconception in the note-book of each of the party. An admirable start this. But what is it compared with the mental discipline that goes along with the making of a geological map, and the grip of the subject that results from this form of geological work? There is as much difference between the two as between that form of sport which consists in riding behind a pack of hounds who follow a trailed herring, and the stalking of deer in their native wilds.

It is in mapping more than in any of its other branches that geology rises to the level of an educational tool. Here there must be the instinctive skill, acquired by long practice, which leads the surveyor to select in his preliminary work the traverses most likely to give a broad view of the structure of the district he is working over; the patience which forbids, when the first rough sketch comes to be filled in, that a single square yard of ground shall be left unvisited, lest some bit of evidence should be missed; and the constructive power which pieces together the accumulated mass of multifarious data into a consistent whole. Keenness of eye, neatness of hand, judgment, unwearied application, and chastened imagination figure among the requisites for the work, and grow in strength as it proceeds. Surely the finishing touch in a geologist's education is given by the making of a geological map.

That the art cannot be learned from books alone, goes without saying; that books can do but little towards teaching it, may be safely maintained. But there is no reason why a master should not give us in print all the aid that a book can afford, and lure us to the fascinating pursuit by an eloquent description of its charms. And that a book which deals with field-geology has been found of service, and that geologists are not averse to hear the praises of their favourite employment, are proved by the fact that the little book on this subject by the Director-General of the Geological Survey is now in its fourth edition.

The work is primarily addressed to geologists, but it appeals also to those who have no claim to so distinctive a title, and no wish for it. It shows how much pleasure may be derived from an acquaintance with the science no larger than any intelligent person may easily acquire; how even this moderate amount of knowledge enhances the enjoyment of travel and of the daily walk. But let the author speak for himself.

"To those who are fond of country rambles geology offers many attractions. Few men are so unobservant as not to be struck, now and then, by at least the more salient features of a landscape. Even in a flat, featureless country, the endless and apparently capricious curvings of the sluggish streams may occasionally suggest the question why such serpentine courses should ever have been chosen. But when the ground rises into undulations, and breaks out into hills or crags; still more, when it towers into rugged mountains, cleft by precipices down which the torrents are ever pouring, and by ravines in the depths of which the hoarse streams ceaselessly murmur, one can hardly escape the natural curiosity to know something about these singular aspects of the landscape, when and how they arose, and why they should be precisely as they are."

Our author goes on to say that "the day is now happily past when the sterner features of the land awakened only a feeling of horror; when they were styled hideous and unsightly; when they were never visited save under the necessities of travel, and were always left behind with a sense of relief." That the appreciation of the beauty of mountain scenery is a taste of modern growth can hardly be disputed. It is open to question whether the comforts of modern travel have not done as much to foster it, as a scientific curiosity to know how the forms which charm our eye were produced. But, however this may be, the awakening and the satisfying of such curiosity are added items to the stock of pleasures which the lover of Nature derives from her wilder aspects.

Some of the inducements to field-work having been thus attractively put forward, the author defines the aim of the book. The student

"must betake himself to Nature from the first. His lessons in the field should accompany his lessons from the text-book or lecture-room. In many cases he must grope his way without guide or assistance. . . . The following chapters are offered for his help. . . . Their aim is to point out how observations may be made, what kinds of data should be looked for, what sort of evidence should be sought to establish a conclusion, and what deductions may be drawn from particular facts. In short, they are to be regarded as sign-posts pointing out some of the highways and byways of geological inquiry, but leaving the reader to perform the journey in his own fashion."

At the outset it is made clear that, though some localities supply more material than others, even the most unpromising are far from barren of interest to those who have eyes to see. The necessary equipment is fully described. In addition to the "cheese-taster" mentioned on p. 29, the portable boring-apparatus devised by Belgian geologists has been found useful. So much stress has been already laid on the value of mapping, that it will be enough to say that, in the author's opinion, the geologist "acquires by it a thoroughness of grasp attainable in no other way." It would have been well if the meaning of contour lines, and the way in which hill-shading is used to denote the shape of the surface, had been treated of more fully. The illustrations of the sinuosities of outcrop across uneven ground, on p. 101, are beautifully distinct, but nothing is said as to the value of models in making clear this point to the beginner. Of course they tell most when he makes them himself: a little modelling clay can generally be obtained; but, in default of better material, an apple or turnip can be made to do good service. In the very handy approximate rule, on p. 116, for determining the thickness of a bed when its dip and the breadth of its outcrop are known, it is not stated that the surface on which the breadth is measured must be horizontal; or, if it be an inclined plane, we must substitute for dip the sum or difference, as the case may be, of the dip of the bed and the inclination of the plane to the horizon. The error committed in using this rule for a dip of 5° is a little over 4 per cent. in defect; it decreases as the dip increases up to 30°: for that angle the rule is accurately true. For dips over 30° the rule gives the thicknesses too great; the error increases rather rapidly with the dip, and at 45° amounts to 6 per cent.; for a dip of 50° it is nearly 9 per cent.

The great value of the book consists in this: from beginning to end it embodies the experiences of one who has spent a lifetime in field-work, and so it is full of "wrinkles" which could not possibly have been picked up in any other way. Most of these anyone who has in him the making of a field-geologist would sooner or later have found out for himself; but it is no small gain to the beginner to be put on the right track to start with, and to have his instructions conveyed with the life and freshness that practical acquaintance can alone give. The present writer feels proud that in one respect he can claim even a more extended experience than the author of the book: the latter, apparently, has never been suspected of being an incendiary (see p. 20), a fate which once befell him who pens this notice. A. H. Green.

## THE LAND OF THE LAMAS.

*The Land of the Lamas: Notes of a Journey through China, Mongolia, and Tibet.* By William Woodville Rockhill. With Maps and Illustrations. (London: Longmans, Green, and Co., 1891.)

Mr. Rockhill has for so long a time taken special interest in Tibet that he is able to speak of it as his "life hobby." Accordingly, when, in 1884, he was attached to the U.S. Legation at Peking, he looked forward with pleasure to the chance of exploring the country; and he began to make the best of all preparations for the undertaking by studying the Tibetan language. At this he worked for four years, during which he also gave some time to the study of Chinese.

In the winter of 1888 he resigned his post of Secretary of Legation, and made ready for his long-anticipated journey. He determined to enter Tibet from the north, and started from Peking on December 17. The choice of this route made it necessary for him to make in the first instance for Lan-chou, the capital of the province of Kan-su; so he arranged with a cart firm to supply him with two carts, with two mules to each, to take him there in thirty-four days. For every day over this they were to pay him two taels, he giving them the same amount for every day gained on the date agreed upon. This plan worked admirably, and he reached his destination two days ahead of time. The distance was 1350 miles.

From Lan-chou, Mr. Rockhill advanced to Hsi-ning, the residence of the Chinese Imperial Controller-general of the Koko-nor, an official known to the Tibetans and Mongols as the Amban. As this magnate was strongly opposed to foreigners, Mr. Rockhill made off from Hsi-ning as soon as possible, going to Lusar, a village near Kumbum. Kumbum is a great religious centre, and he was fortunate enough to be present on the 12th of the first moon, when the Chinese in every village and town of the empire celebrate the dragon festival. After looking through one of the temples, he and those who accompanied him walked round it, keeping it on the right hand—"a mode of showing respect for sacred things observed in all lamaist countries." At a lamasery in the neighbourhood, where he found a native who had taught him Tibetan at Peking, he had much pleasant talk with various lamas. These authorities were, he says, "immensely amused" by what he had to tell them about esoteric Buddhism and the Mahatmas.

Mr. Rockhill's final preparations were made at Tankar, the most westerly border town in that part of Kan-su. From this place, with his men, he set out on March 24, 1889, and was soon across the frontier. His intention was to visit Lh'asa; and had he succeeded in carrying out this plan, his narrative would probably have taken rank among the foremost modern books of travel. Unfortunately, the difficulties in the way proved to be insuperable, and he was obliged to content himself with a much less ambitious enterprise. The first country traversed by the party was Koko-nor, their route taking them past the northern shore of the great lake from which the region derives its name. This lake is some 230 miles in circumference, and its altitude is about 10,900 feet above sea-level. Looking at it from a low pass to the north-east, Mr. Rockhill describes it as "a glistening sheet of ice, stretching as far as the eye could reach to the west, and bounded to the south by a range of high, bleak mountains with snow-tipped peaks." To the north and west of the lake there is fine grazing-land, which is watered by many streams. Here nomads find excellent camping grounds in swales and hollows, which afford protection from violent west and north-west winds.

After leaving Koko-nor, the party passed in a southerly direction through Ts'aidam, crossing the Timurté

Mountains, beyond which they entered the desert of Koko Beileh. Starting from the village of Shang, in Ts'aidam, Mr. Rockhill explored a district which Prjevalsky did not find it convenient to visit. Here he followed the course of the Yohuré, on the left bank of which a range of mountains culminates in a peak which Mr. Rockhill estimated to be between 17,000 and 18,000 feet above sea-level. This peak he called Mount Caroline. The district was everywhere "literally alive with game," yak and wild asses being particularly plentiful. Of the Mongols of Ts'aidam, Huc and Prjevalsky have given very unfavourable accounts. Mr. Rockhill found them honest and hospitable; and he says they are much more devout Buddhists than the Koko-nor Tibetans. Among the latter, the laity "do not bother themselves about praying, thinking that they pay the lamas quite enough to do all that is necessary for their good," whereas the Ts'aidam Mongols "are continually mumbling prayers, twirling prayer-wheels, or perhaps doing both at the same time." At Shang a pole supporting two prayer-wheels was attached to the roof of nearly every house. The wheels were put in motion by the wind, which was caught by a simple arrangement of wooden cups fixed on the ends of horizontal sticks, and looking like our anemometers.

From Ts'aidam the party entered North-Eastern Tibet, and here they traversed for the most part a bleak country until they were some way beyond Jyékundo. The country between the range to the south of Alang-nor and the source of the Yellow River has an average altitude of about 14,500 feet; and at this height the horses and dogs soon showed signs of great fatigue. "We felt no brighter than the animals," says Mr. Rockhill; "our clothes seemed to weigh tons, our guns loaded us down, and walking, even on the level, was such a violent effort that perspiration poured down our faces." They were repeatedly warned that it would be impossible for them to cross the Dré Ch'u or upper Yang-tzu Kiang. The passage, however, was effected without serious difficulty. At the point where they first saw it, the river was of a beautiful blue colour. It was about 120 yards wide and 20 feet deep, and flowed swiftly between high, bare, reddish mountains. South of the Dré Ch'u they crossed the Zonyik Valley (altitude, 16,300 feet), at the head of which they saw twelve argali, a kind of sheep which is said to be not uncommon in the wilder gorges along the river. The snow was so deep, and any exertion so exhausting, that Mr. Rockhill did not try to get a shot at them. Beyond this valley the party came to Taglung-la, (altitude, 16,650 feet), the highest pass crossed in the course of the whole journey.

Jyékundo proved to be a pretty place, nestling at the foot of a high, steep hill crowned with the brightly coloured walls of a lamasery. After the fatigues the party had undergone, Mr. Rockhill wished very much to spend a week or two at this village; but the abbot of the lamasery, who was the chief of the district, was so bitterly hostile that they had to depart in haste. During the first day's journey beyond this point the country remained bare and bleak; but when, on the following day, they entered the Dren-kou valley, which leads down to the Dré Ch'u, the scenery "changed as if by magic." They found themselves in a fertile and picturesque glen, where juniper and pine trees grew on the mountains, while by the roadside were plum, gooseberry, honeysuckle, and other shrubs, the fragrance of their blossoms filling the air. A brook flowed between banks covered with soft green grass "powdered over with little white and pink flowers." During the remainder of the journey Mr. Rockhill was often troubled by the lamas, but in other respects his difficulties were less formidable. The route passed through many villages, and he often has occasion to express admiration for the charm of the scenery. Advancing in a south-easterly direction, he came to Dérgé, the richest agricultural and manufacturing region of Eastern Tibet, and the most densely populated. It is especially famous for the excellence of its metal-work. Mr. Rockhill spent some days at Kanzé, the chief city of the Horba country, the inhabitants of which seemed to him the best-looking people he had seen in Tibet. Lu, the Chinese official stationed at Kanzé, warned him that he might encounter serious dangers beyond that city, and insisted on his taking an escort of four Chinese soldiers. Talking of wild tribes to the north of the Horba country, this official assured Mr. Rockhill that men in a state of primitive savagery were found in Tibet. Lu himself had seen a number of wild men who had been driven out of woods by a forest-fire on the flank of Mount Ka-lo, east of Kanzé. "They were very hairy, their language was incomprehensible to Tibetans, and they wore most primitive garments made of skins. He took them to belong to the same race as the Golok, of whom many lived in caves in a condition of profound savagery." From Jyékundo to Dawo, Mr. Rockhill followed the route which had been taken by Pundit A— K—, or Krishna, in 1882; but from Dawo to Ta-chien-lu he chose a different way, and thus had an opportunity of studying a new section of country, which he carefully describes. At Ta-chien-lu, his travels, so far as Tibet was concerned, came to an end. He had still before him, however, a long journey in China, and of the more striking part of it he gives an excellent account, presenting with special vigour the incidents of a trip down the Yang-tzu Kiang, which had "just enough of danger in it to give it zest."

Mr. Rockhill writes simply and clearly, and geographers will read with interest all he has to say of the more remote regions through which he passed. His remarks on the people are not less valuable. It is stated by Chinese writers of authority that for every family in Tibet there are three lamas, and Mr. Rockhill does not believe that this is an exaggerated estimate. From Jyékundo to Ta-chien-lu, a distance of about 600 miles, he passed forty lamaseries, in the smallest of which there were 100 monks, and in five of them from 2000 to 4000. Their landed property is in many cases enormous, and their serfs and bondsmen swarm. There are four lamaist sects, called by the Chinese, yellow, red, black, and white lamas; but the laity do not attribute much importance to the differences between them. In Eastern Tibet there is also a creed known as "Bön." It represents the pre-Buddhist Shamanism of the country. The "Bönbo" are held in great scorn by the lamas; but as their charge for "beating the drum" is exceptionally low, they are readily invited to the houses of the common people for religious services.

Mr. Rockhill is of opinion that polyandrous marriages, although frequently met with, are not by any means so numerous in Tibet as we have hitherto been led to suppose. Polyandry exists only in agricultural districts, and he suggests that it is maintained there because the tillable lands are of small extent, and every family feels it to be important that the ancestral estate should not be divided. This, however, as he himself points out, can at best explain, not the origin of polyandry, but merely the fact that the custom is still permitted to survive.

We may note that the illustrations are excellent, and that two good maps make it easy for the reader to trace the author's route.

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## SCIENCE AND BREWING.

*A Text-book of the Science of Brewing.* By E. R. Moritz, Ph.D., and G. H. Morris, Ph.D. Based upon a Course of Six Lectures delivered by E. R. Moritz at the Finsbury Technical College. (London: E. and F. N. Spon, 1891.)

BREWING is an industry which, as a rule, does not excite the interest in scientific minds that it deserves. The reason is difficult to explain, for there is no industry which involves more problems of general scientific moment, or makes more varied calls on the different sciences. As an illustration—noting very briefly a few points in the manufacture of beer—we have in malting a study of the embryological development of the barley plant, and the secretion and use by the growing embryo of those curious enzymes which render both the carbohydrate and proteid food of the endosperm available; in the mashing, or infusion of malt with water, we meet with the action of the enzyme, diastase, upon starch, involving some of the most complex molecular changes known; and in fermentation, produced both by the Saccharomyces and Bacteria, we have all the interesting difficulties connected with the morphology and zymotic powers of these organisms. It is evident that any technical scientific work on such subjects as those just mentioned, involves questions of the greatest general scientific interest, and touches on points at the extreme limit of our present knowledge; consequently, it is not surprising to find that science owes some most important advances to scientific workers in the field of brewing. For instance, our knowledge of the constitution of starch, and the changes it undergoes during hydrolysis by the action of acids and diastase, is almost entirely due to the researches of C. O'Sullivan and of Horace Brown, both connected with the industry of brewing.

Dealing, then, as the science of brewing does, with some of the most complex problems known, investigations in this field of work carry with them more than ordinary technical interest, and should excite more general interest in the scientific aspect of the industry than seems to be accorded to it at present. A perusal of Drs. Moritz and Morris's "Text-book of the Science of Brewing" has induced us to make these remarks, for contained in this work we find for the first time a lucid and correct account of the important scientific principles involved in the brewing industry, and the work that has been done upon them. Although, of course, mainly written for technical purposes, the authors have treated the whole of their subject in such a manner that the book undoubtedly has a general scientific value beyond the circle of those for whom it is mainly intended. We are sure that anyone wishing to look up such subjects as starch and its transformations, or fermentation, would do well to consult this work, for, apart from the admirable *résumés* of our present knowledge on such subjects, the abundant references given, to the authors quoted, are themselves of much value.

Hitherto there has been great want of a technical guide to the scientific principles of brewing, nothing in the least worthy of such a name having been published; and the unfortunate student of this subject has been compelled to attempt the almost impossible task of collecting his information from a literature scattered far and wide, with no guide to teach him how to do it, or how to select the good from the bad when it was done. His difficulty is now over, we are pleased to say, for in Drs. Moritz and Morris's work we find a technical guide that ranks with the best of those written on any subject, and we feel sure that it will assist in a marked way in spreading a more general knowledge of the real principles of the brewing industry. One aim of the authors has been, not only to lay before their readers the present state of scientific knowledge with regard to brewing, but also by their experience as brewers to draw practical deductions from this knowledge. This part of their subject they have approached in a very fair and impartial spirit, and they have not hesitated to call attention to those points on which knowledge is at present too restricted to justify drawing deductions of any value. Those who are acquainted with the *quasi*-scientific writing that prevails in some of the brewing trade periodicals, will thoroughly appreciate this. We trust that the appearance of Drs. Moritz and Morris's work will raise the general tone of technical brewing literature, an end much to be desired.

In attempting to write a text-book bringing the scientific principles and the practice of brewing together, the authors undertook a difficult task, and one that could only be done by those who have a thorough grasp of both branches of the subject. They have been most successful in their effort, and we commend their work to the notice of all students of brewing, and to all those brewers who take a rational interest in their own business; such cannot fail to derive much benefit from a careful study of it.

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## A THEORY OF GRAVITATION.

*Fresh Light on the Dynamic Action and Ponderosity of Matter.* By "Waterdale." (London: Chapman and Hall, 1891).

THE original aim of this work was the discovery of some reason, other than the hypothesis of attraction, to account for the gravitation of one body towards another.

The writer thus takes up the subject of gravitation where it was left by Newton two hundred years ago. The "Principia" concludes with these words—

"Rationem vero harum Gravitatis proprietatum ex Phænomenis nondum potui deducere, et Hypotheses non fingo. Quicquid enim ex Phænomenis non deducitur, *Hypothesis* vocanda est; et Hypotheses, seu Metaphysicæ, seu Physicæ, seu Qualitatum occultarum seu Mechanicæ, in *Philosophia Experimentali* locum non habent."

"Adjicere jam liceret nonnulla de Spiritu quodam subtilissimo corpora crassa pervadente, et in iisdem latente, cujus vi et actionibus particulæ corporum ad minimas distantias se mutuo attrahunt, et contiguæ factæ cohærent." "Sed hæc paucis exponi non possunt; neque adest sufficiens copia Experimentorum, quibus leges actionum hujus Spiritus accurate determinari et monstrari debent."

Now the present work of "Waterdale" is all Hypothesis from beginning to end; and there is no careful detailed experiment to be found described in the book, by which the various Hypotheses brought forward by him can be tested.

At a first glance the theory seems a revival of the Cartesian Theory of Vortices, advanced in Newton's day by Descartes to account for the motion of the celestial bodies, and the difficulties attending this Theory are pointed out by Newton in his "Scholium Generale"—

"Hypothesis Vorticum multis premitur difficultatibus. Ut Planeta unusquisque radio ad Solem ducto areas describat tempori proportionales, tempora periodica partium Vorticis deberent esse in duplicata ratione distantiarum a Sole," &c.

This ancient theory is attributed by our author to F. Major, in his recent work, "Spacial and Atomic Energy," Parts I. and II.; but the author himself gives, as the primary reason for gravity, the *mutual shelter* to opposite wave-energy afforded by two spheres or bodies; and now, if "Waterdale" is anxious to convert the scientific world, he must utilize the quantitative theoretical results, worked out by Lord Rayleigh, on the Apparent Attraction due to Vibration.

The book abounds with curious unfamiliar dynamical expressions, such as *real*, *vested*, *imposed*, and *specific ponderosity*, *force of diversion*, *rectangular velocity*, *concentering preponderating energy*, *film of transplacement*, &c., of which no definitions are given; and altogether the treatment is unconventional in the extreme.

"Waterdale" concludes by asking that the question of *mechanical perpetual motion* should be reopened, and that pure mathematics should be once more applied to the subject—

"*Perpetual motion* has already been granted to us. By the burning of coal and evaporation of water we have work performed for us by Nature. Perpetuate the process, and the work is also perpetuated. We have many ways of acquiring this gift from Nature's stores, and one more possible method need not startle the human mind."

This method of *quasi*-scientific argument is familiar to us, in the newspapers, in the account and explanation of Spiritualistic Phenomena. A. G. G.

## OUR BOOK SHELF.

*Indischer Ozean: ein Atlas die Physikalischen Verhältnisse, und die Verkehrs-Strassen darstellend.* (Hamburg: Deutsche Seewarte, 1891.)

THESE maps of meteorological and other physical data for the Indian Ocean, while giving a very fair idea of the prevailing conditions, are scarcely equal to the scientific requirements of the present year of grace.

While it may be freely confessed that our knowledge of the area dealt with is yet very imperfect, and that the scale of this handy atlas does not permit of great refinements, there are many details to which exception may fairly be taken. A few instances may be given.

In the map of general depth no indication is furnished of the extreme sparseness of the soundings from which the various coloured areas are drawn.

The current charts are depicted with a hardness and regularity with regard to the different streams that are scarcely consistent with nature. The ever-varying circumstances of the monsoons render the currents of this ocean especially changeable, and it would be preferable to indicate this characteristic by lines more broken. In the sheet of the north-east monsoon period, the meeting of the two main currents on the East African coast never takes place so far south as is shown, nor is there any justification for the peculiar direction of the line between them to the eastward.

It is a bold thing to attempt to portion the sea into areas of definite surface specific gravities. The data are very scanty.

The pressure charts, which are given for the same months as those published by the Meteorological Office, and the map showing the relative prevalence of winds, are good; but here again the absence of the data on which the various quantities in different areas are founded is a serious flaw.

The different maps are well got up, and bear further witness to the general excellence of German lithography.

*Mechanics for Beginners.* Part I. Dynamics and Statics, By the Rev. J. B. Lock. (London: Macmillan and Co., 1891.)

MR. LOCK states that the work before us contains the more elementary parts of the dynamics of a particle and of the statics of parallel forces, arranged with some additions from his "Elementary Dynamics and Statics." The author's mode of treatment will be familiar to many of our readers, and we need hardly say that Mr. Lock slurs over no difficulty that presents itself to the young student of this difficult subject. We have read the whole of the text with much interest, and pronounce it to be excellent. A boy who has gone through this, and worked out the examples in the manner shown him by the author, will be well equipped for more advanced treatises. A novelty, to which Mr. Lock draws attention, is a new form of "that proof of the formula of accelerated motion which depends upon the idea of average velocity." This proof appears to be a satisfactory one. There is an interesting combination of Morin's and Atwood's machines, which is likely to furnish a useful illustration to students. The work is split up into eight sections—rectilinear motion, motion in one plane, forces acting at a point, parallel forces, machines, uniform motion in a circle, energy, and the pendulum. The arrangement has been made to meet the special wants of the Science and Art Department. It is suited for any junior students. Article 16 appears to us to be likely to be too difficult for a boy; if so, he can pass on, and return to it subsequently. We have not worked out the examples which accompany the several chapters, and to which answers are given at the end. The following errors we have noted: p. 17, l. 8 up, dele $a$ in $an$T; p. 19, l. 5 up, the first 2 N's should be N′; p. 20, last line, for 252 read 162; p. 52, l. 1, it would seem to follow that "when one mass meets another mass of the *same* velocity" they would not be said to *impinge*. What would they be said to do? P. 67, the term *resolute* is defined, reference might be made to p. 92; p. 68, l. 1, dele $a$; p. 72, l. 8 up, for Q read H; p. 94, l. 7, for an = read +; p. 115, l. 7 up, read $10-x$; p. 139, l. 2, for 4 read 3; p. 205, last line, numerator, for cos $a$ read sin $a$; p. 208, l. 20, supply $g$; p. 246, l. 8 up, for second $g$ read $g_1$. The greater number of these errors are trifling, and will not give the private student much trouble; we have pointed them out because we know what a stumbling-block even slight mistakes are to such students. Their reverence for printed results is often wonderful. The utility of Mr. Lock's "Higher Trigonometry" is greatly hindered by the number of typographical blunders.

*The Physical Geology and Geography of Ireland.* By Edward Hull, F.R.S. Second Edition. (London: Edward Stanford, 1891.)

THE first edition of this book was reviewed in NATURE rather more than thirteen years ago (vol. xviii. p. 354). Of the second edition, which will be welcomed by all students of the subjects it deals with, we need only say that Prof. Hull has embodied in it the additions which have lately been made to our knowledge of the geological structure of Ireland. The more important of these additions he sums up under the following heads:—(1) The determination of the occurrence of Archæan rocks in certain districts of the west and north of Ireland. (2) The determination of the peculiar relations subsisting between the Lower Devonian (or Devono-Silurian) strata and the Upper Old Red Sandstone and Carboniferous series of the southern districts. (3) Additional evidence regarding the relative ages of the trachytic and basaltic lavas of Antrim. (4) Evidence of the invasion of Ulster by a great ice-sheet from the Grampian Mountains of Scotland during the earliest stage of the Glacial period.

*The Ouse.* By A. J. Foster, M.A. (London: Society for Promoting Christian Knowledge, 1891.)

IN this little book the course of the Ouse is traced from its source to the point where it enters the sea, and some account is given of the various elements of interest that are to be met with on the way. The idea is good, and the author has worked it out skilfully. Any boys or girls who may read the volume will find at the close that they have obtained from it much sound geographical knowledge.

## 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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### A Difficulty in Weismannism.

IN your number of October 29 (vol. xliv. p. 613), Prof. Hartog depicts a dilemma in which a study of Weismann's theories has placed him.

Prof. Hartog sums up the main points of Weismann's theories in five theses, but, considering the great importance which the latter attaches to the operation of *natural selection*, he might well have added a *sixth* to the list.

There can be no doubt that, of the two hypotheses brought forward in the letter, hypothesis B is the one adopted by Weismann for the explanation of the problems of heredity. We are therefore not concerned with hypothesis A.

"According to hypothesis B," Prof. Hartog states, "the Ahnenplasmas of all Metazoa being similar and Protozoan, if the *numbers are equal* and the shuffling fair, any two parents may beget any offspring whatever; . . . a lioness might be expected to bring forth a lobster or a starfish, &c."

What does Prof. Hartog mean by *fair shuffling?* Surely not such shuffling as is resorted to in the game of whist, but such shuffling as he himself describes in thesis 4. He states here that the "process is comparable to the shuffling of two packs of cards by taking half from each and joining the talons or remainders to form a new pack."

It surely cannot be imagined that Weismann ever intended to assert that with each sexual act there was a rearrangement of the Ahnenplasmas comparable to the shuffling of a pack of cards during the game of whist.

Did he anywhere asert this, we should naturally expect him to believe that a lioness might as well bring forth human beings or lobsters as normal cubs.

With the evolution of sexuality, the excessively numerous Ahnenplasmas of our variable Protozoan ancestors became *arranged* in more and more complex, ever-varying *combinations.* At the very outset, natural selection operated. The variations (due to the combinations) most advantageous to the species were perpetuated. Unfavourable variations involved extinction. It is the *special combination* of the units of ancestral germ-plasm which predetermines the structure of the mature individual. This combination, of course, is very closely related to the two combinations from which it arose, and it is just this closeness of relationship which prevents us from supposing that a lioness can ever produce anything but cubs. Changes in the combinations are only slowly effected. The influence of the mother is due to the fact that one-half of the maternal combination is present in the offspring, and similar statements can of course be made concerning the influences of father, grandfather, great-grandfather, &c.

Do not these two considerations—(1) that the nature of the individual depends upon the *peculiar combination* of units of ancestral Protozoan germ-plasm, a combination very closely related to two previous ones (owing to the fact that, in sexual union, two halves of immediately preceding combinations are united to make one whole); (2) that the operation of natural selection provides for the *extinction* of *useless*, and the *preservation* of *useful* variations—afford to Prof. Hartog the means of escaping from his dilemma? A. H. TROW.

Penarth, Cardiff, November 14.

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THE contributions of Mr. Trow and Dr. Poulton to this discussion render necessary an explanation that should, perhaps, have accompanied my first letter. After rough-drafting this, I felt misgivings lest I might have misconceived Weismann's meaning, and set up a man of straw to knock down. Accordingly, I wrote to Prof. Weismann to ask if I rightly understood his meaning, explaining my object in doing so; and he answered my queries with great kindness, courtesy, and fulness. As I wrote back to him, I then thought it better, relieved from my misgivings, to state the point without reference to his letter. But Mr. Trow and Dr. Poulton have both blamed my use of the word shuffling, and appear to think that my hypothesis A is a purely imaginary conception of the straw man order. I hope, therefore, I shall not be accused of having wilfully kept a trump card up my sleeve if I now quote the two essential passages of Prof. Weismann's letter, which were written in definition of the points at issue.

"Ich denke mir dass das Keimplasma eines Individuum's aus einer gewissen Zahl von Einheiten besteht, welche untereinander sehr ähnlich, aber nicht gleich sind. Die Unterschiede zwischen ihnen entsprechen meist den Unterschieden zwischen je zwei Individuen derselben Species. *Jedes derselben würde im Stande sein ein Individuum der Art hervorzubringen falls es sich zu der dazu nöthigen Masse vervielfältigen könnte oder würde.*" The sentence I have italicized corresponds, I think, very fairly to my hypothesis A: "Each Ahnenplasma unit corresponds to an individual of the species itself; and if put under suitable trophic conditions would, singly, reproduce such an individual." Dr. Poulton writes: "I agree with Prof. Hartog in considering it [Hypothesis A] as valueless." I am far from considering any hypothesis as valueless which upsets a wrong theory of which it should be the mainstay.

Prof. Weismann goes on: "Sie können ganz wohl die geschlechtliche Fortpflanzung mit dem Mischen eines Kartenspiels vergleichen, aus dem immer die Hälfte der Karten entfernt wird. Nur ist nicht zu vergessen dass die Karten selbst nicht völlig unveränderlich sind." It is obvious that Prof. Weismann accepts the peculiar mode of shuffling I have described (not the ordinary mode at whist), as a fair illustration of his conception of fertilization and its antecedents. He always speaks of *combinations* in his "Essays," and not *permutations.* The reason is obvious: the figured elements of the living nucleus are constantly changing their relative position; and it is these that are the outward and visible sign of the mysterious ancestral units.

Hence Dr. Poulton's very pretty kaleidoscope simile involves new suppositions, which are worse than gratuitous because they involve throwing overboard the very facts on which the theory was originally based. It is plain that Dr. Weismann goes very much further in admitting the changeability of the ancestral units than his disciples are willing to do; and I have shown that hypothesis A involves the conclusion that these are indefinitely changeable, not merely "not completely unchangeable," as Prof. Weismann writes.

Another point for consideration is that we can hardly doubt the monophyletic origin of Metazoa, and that, at least excepting Cœlenterates and Sponges, they all originated from some one primitive form. The Protozoan ancestors of this form must have belonged to the same species with one another, and their representative ancestral units cannot have been more different than the members of a single species. Hence, without selection, the germ-plasm composed of a number of these units associated together would give an average resultant, so that the majority of individuals would be more similar than the ancestral units of their germ-plasms, and amphigony would produce uniform offspring on the whole. Divergence from the average type could only occur by the duplication or further repetition of single ancestral units of special character; and these variations would be the material for natural selection to act upon. Thus, among words of eleven letters, such a word as *abracadabra*, with its 5 *a*'s, 2 *b*'s, and 2 *r*'s, would have a marked divergence from the type as compared with groups in which no letter occurred twice over.[1] If, then, natural selection goes on to form a species according to Weismann's theory, it can only do so by eliminating certain ancestral plasms and duplicating or further repeating others to take their place. Once an ancestral plasm eliminated in the formation of a race it can never be re-introduced, or replaced by a new one. But as soon as we repeat certain members of a group of limited number we reduce the possible number of permutations or combinations that can be formed from that group. Anyone with a fair head for the work, and a Todhunter's "Algebra," can see for himself how very rapidly the number of combinations is reduced in this way. Thus natural selection could only result in arrangements of ever-increasing simplicity and similarity instead of complexity and divergence. The ultimate product would be a limited number of well-marked species, whose individual members had lost all power of variation. This I offer as an alternative to the variable offspring of the lioness.

Mr. Trow is extremely anxious to show me a path out of my dilemma. It presents no difficulty to those biologists who consider the conception of a germ-plasm independent of the somatoplasm as more or less mythical. For those who follow Weismann, the way out of the difficulty will not lie through the ascription to natural selection of powers which it cannot possibly exert.

MARCUS HARTOG.

Cork, November 28.

[1] The argument above was suggested to me by a chemical friend.

### The Mexican Atlatl or Spear-Thrower.

THE note in NATURE of November 19 (p. 66) recording the important discovery at Lake Patzcuaro, Mexico, of "a modern atlatl (not altatl, as misprinted) well worn and old-looking, accompanied with a gig for killing ducks," is very interesting. It may not be out of place to call attention to an exhaustive little memoir by Mrs. Zelia Nuttall on "The Atlatl or Spear-Thrower of the Ancient Mexicans," published this summer in the third number of the first volume of the "Ethnographical and Ethnological Papers of the Peabody Museum" (Cambridge, Mass., 1891). In this paper, which is illustrated with eighty figures of different kinds of atlatl, the author completely establishes the existence and practical use in warfare of the wooden spear-thrower or atlatl by the Mexicans at the time of the Spanish conquest, although some doubt had been expressed in the matter by such well-known authorities as Prof. E. B. Tylor and Mr. A. Bandelier, while Mr. H. H. Bancroft even stated that "he had not found any description of its form or the manner of using it." Mrs. Nuttall, however, reproduces numerous illustrations of the many varied forms of the atlatl from different *codices*, accompanied by several descriptions of the manner of hurling the weapon, cited from old Spanish writers. Perhaps at this moment the most *à propos* is that from the ancient chronicles of Tezozomoc, who, in describing the drill of the soldiers, relates "how their chiefs ordered them out in canoes to practise throwing spears at flying ducks before engaging the enemy in warfare." Mrs. Nuttall was enabled to trace, by means of a careful study of a MS. edition of "Sahagun's Historia," preserved in the National Library at Florence, the complete evolution of the atlatl from the simple form used by the native hunter to launch the harpoon with two or three barbs at the fish or water-fowl of the lagoons. This had a cord attached to retrieve the game. "Minus the cord, the spear-thrower became part of the necessary equipment of every soldier of a certain grade," and was used with fatal effect, as Bernal Diaz most distinctly states, in opposing the advance of the Spanish adventurers. Elaborately decorated forms first became the emblem of chieftainship, and ultimately symbolic of the Aztec deities, and were borne aloft by the chief-priestly warrior and representative of the gods in ceremonial processions. The maximum of development was attained in the symbolic "blue atlatl" or "blue serpents," inlaid with gold and richly decorated with feather-work, described as "bishops' crosiers" by Cortes, who sent specimens presented to him by Montezuma II. to the Court of Spain. Some examples are still preserved in the Ethnographical Museums of Berlin and Vienna, and in the British Museum.

It was in the course of these researches that Mrs. Nuttall made the important identification of the atlatl "as the hitherto unrecognized weapon" grasped by the warriors sculptured on the "so-called sacrificial stone of Mexico," and also by the warriors depicted in Stephens's illustrations of the *bas-reliefs* adorning the ruins at Chichen-Itza in Yucatan. The different myths relating the invention or origin of the *atlatl* are collected and explained, and the following very practical philological derivation of the name *atlatl* is offered by her as a suggestion supported by a series of careful analyses:—

"The Aztec word *atlatl*, or *atlatli*, is intimately connected with the verb *tlaça* = to aim, to throw, or cast. From this verb a whole series of words is formed, as *tlatlacaliztli* = the act of throwing, &c.; *tlatlaxtli*—the object thrown; *tlatlçani* = thrower. The name atlacatl—a synthesis of *âtl*, water, *tlacatl*, men—was applied to the fishermen, the original users of the atlatl; and it is suggested that the word atlatl may primarily have been a synthesis formed with the verbal noun *tlatlaçani* = thrower, and *âtl*, water, which would give the word *atlatlaçani*, meaning water-thrower, not an unfit name for the harpoon-thrower of the watermen" (p. 12).

This interpretation is certainly not weakened by the recent discovery that the primitive form of atlatl is still in use in the lake regions of Mexico. In other respects Mrs. Nuttall's paper well repays perusal by all interested in Mexican antiquities.

A word with reference to Prof. Otis Mason's remark "that the problem now is to connect Alaska with Mexico." Given hungry aboriginal man in the foreground, and fat wild ducks in what artists term "the middle distance," it does not seem wholly irrational to surmise that the *atlatl*, or spear-thrower, was independently evolved in suitable environments. Does not the average nineteenth-century boy still betray a strong innate tendency to throw or sling stones at every bird he sees? Perhaps this is but accumulated inherited instinct, not yet eradicated by civilization. It is at all events certain that the *atlatl* was widely used by the aboriginal inhabitants of the American continents, as Prof. Max Uhle's researches testify abundantly.

Brighton, November 21.

AGNES CRANE.

### The Chromosphere Line Ångström 6676·9.

WITH regard to Prof. Young's observations as to the non-coincidence of the bright chromosphere line (NATURE, November 12, p. 28) with the corresponding dark line 6676·9 of Ångström's scale, it may be interesting to note that Profs. Liveing and Dewar have observed a barium line at 6677, which is therefore slightly less refrangible than the dark solar line. In his catalogue Prof. Young also gives a barium line at 6018·0, which is identified with Kirchhoff 933·8. In the course of the observations of sun-spot spectra taken at Stonyhurst with a twelve-prism spectroscope, no dark solar line has been noted in this position except in two uncertain instances over spots. It would be an important fact should two barium lines be found in the chromosphere without corresponding dark lines.

In the period of maximum solar activity the bright line 6676·9 was on several occasions seen in the spectroscope, while the height of the chromosphere was being measured at Stonyhurst on the C line of hydrogen. At these times C was always very bright, and generally displaced in the prominences in which 6676·9 was seen. The latter line was not seen in the observations taken between March 9, 1886, and September 10, 1891. Although both Young and Thollon attribute the line to iron, no iron line is given in this position by either Ångström or the catalogues of the British Association. Dunér, quoted by Thollon, considers the line variable with the state of solar activity, but Ångström seems to have made an error in drawing it as a fine thin line, as Kirchhoff, Burton, Fievez, Smyth, Thollon, and Higgs give it as a strong dark line. Finally, Young, Burton, and the Stonyhurst observers identify it with Kirchhoff's ray 654·3, and Thollon with 641, which latter is a calcium line. There would, then, appear to be some differences of opinion with regard to this important line (cf. *Monthly Notices R.A.S.*, vol. li., No. 1, p. 22.) A. L. CORTIE.

St. Beuno's College, St. Asaph, November 19.

## Peculiar Eyes.

I LABOUR under the peculiar inconvenience of having a right eye of normal power and a short-sighted left eye. The numerals on the face of a clock ⅜ of an inch high are visible to the right eye at 12 feet distant; but in order to discern them as clearly with my left eye I require to bring that organ of vision as near to the figures as 8 inches. On looking at my gold chain hanging on my breast in daylight and with both eyes, the chain, coloured yellow and towards the left, is perceived by the right eye, while a steely blue chain, another, yet the same, is perceived about an inch to the right and a little higher up. By artificial light the same phenomenon presents itself, but the difference of colour is not so apparent; the yellow to the right is only dimmer. Again, when a page of NATURE is being read with the short-sighted eye, there appears, about an inch to the left, part of the same column, small, and the black, under artificial light, like weak purple. The right-hand side of this ghost-like column is lost to the right eye, being commingled with the larger, darker letters seen by the short-sighted left, which cover it like the more recent writing on a palimpsest. Middle life was reached before the discovery was made. These experiences must be gone through with intent, for objects generally being perceived altogether with the right eye, all that the left seems good for is to supply a little more light. The perception of the difference of colour is as good with the one eye as the other, and the short-sighted eye can read smaller type.

As the inferior animals, so far as I know, have no habit of peeping or looking with one eye shut and the other open, it occurred to me that this ability might be a limited one. I tried the experiment with school children, and to my surprise found that a few were quite unable to keep one eye shut and the other open at the same time, and a few did it with an effort, making in all about a fourth of the number. Adults were likewise under similar limits, but to a less extent. This may be the reason why the discovery of inequality of vision, as Sir John Herschel remarks, is often made late in life. Indeed, he mentions an elderly person who made the unpleasant discovery that he was altogether blind of an eye. JAS. SHAW.

Tynron, Dumfriesshire.

## Zoological Regions.

THE last number of the *Archiv für Naturgeschichte*, lvii., which has just appeared, contains (pp. 277–291, pl. x.) an article by Prof. Möbius, dealing with the zoological regions of the earth, chiefly with a cartographical and "museological" object, in which a set of regions is proposed differing in some respects from that most generally in use. The number of land regions is raised to twelve instead of the usual five or six, and the marine world is likewise subdivided into a number of regions. A part of what may appear innovations is in fact nothing but a reversion to the zoological subdivisions of the world proposed by Schmarda ("Geographische Verbreitung der Thiere") in 1853. It seems extraordinary that, although alluding to the works of the principal authorities who have dealt with zoogeography since Schmarda, Prof. Möbius should not have referred to that author otherwise than in a second-hand quotation. For not only did Schmarda lay down the basis on which zoological regions have since been elaborated, but his attempt is, everything considered, in many respects superior to that of his immediate successors in the same field.

It will be seen, on comparing Schmarda's and Möbius's maps, or the table annexed to this note, that several of the regions independently proposed by these authors coincide in their limits, the principal difference being that Schmarda divided the world into a greater number of "Reiche," some of which are merely amalgamated in Möbius's "Gebiete."

G. A. BOULENGER.

| SCHMARDA, 1853. | | MÖBIUS, 1891. |
|---|---|---|
| A. *Festland.* | = | A. *Landgebiete.* |
| I. ArctischesReich .. | = | I. Nordpolar Gebiet. |
| II. Mittel-Europa ... ... | = | II. Europäisch-Sibirisches G. (+ part of Schmarda's I. R.). |
| V. Mittelmeer Reich ... | | |
| III. Kaspische Steppenländer ... ... ... | = | III. Mittelmeer G. |
| IX. Wüste ... ... ... ... | | |
| IV. Centralasiatische Steppen ... ... ... | | |
| VI. China ... ... ... ... | = | IV. Chinesisches G. |
| VII. Japan ... ... ... ... | | |
| VIII. Nordamerica ... ... | = | X. Nordamerikanisches G. |
| X. Westafrika ... ... ... | = | VI. Afrikanisches G. |
| XI. Hochafrika ... ... | | |
| XII. Madagascar ... ... | = | VII. Madagassiches G. |
| XIII. Indien ... ... ... ... | = | V. Indisches G. |
| XIV. Sunda-Welt ... .. | | |
| XV. Australisches Reich .. | = | VIII. Australisches G. |
| XVI. American. Mittelreich | | |
| XVII. Brasilien ... ... .. | | |
| XVIII. Ando-peruan.-chil. R. | = | XI. Südamerikanisches G. |
| XIX. Pampas ... ... ... | | |
| XX. Patagonien ... ... | | |
| XXI. Polinesien ... ... ... | = | VIII. (Part).<br>IX. Neuseeländisches G. |
| B. *Meere.* | = | *B. Meergebiete.* |
| XXII. Arctisches M. ... ... | = | I. Nordpolar M. |
| XXIII. Antarctisches M. ... | | |
| XXX. Südl. Atlant. Oc. ... | = | VIII. Süd-M. |
| XXXI. Südl. Stiller Oc. ... | | |
| XXIV. Nördl. Atlant. Oc. ... | = | II. Nordatlant. M. |
| XXV. S. Eur. Mittel-M. ... | = | III. Mittel-M. |
| XXVI. Nördl. Stiller Oc. ... | = | VII. Nordpacifisches M. |
| XXVII. Trop. Atlant. Oc. ... | = | IV. Südatlantisches M. |
| XXVIII. Indischer Oc. ... ... | = | V. Indisch-Polynesisches M. |
| XXIX. Trop. Stiller Oc. ... | | VI. Peruanisches M. |

## Scientific Nomenclature.

*A propos* of Prof. Parker's interesting article on scientific nomenclature in your issue of the 19th inst. (p. 68), I should like to call attention to the misuse of the term involucre in regard to the Anemone, &c. The so-called involucre of the Anemone is really, morphologically, a calyx, and until the flower-bud has grown to the height of an inch or two from the ground, it to a certain extent performs the ordinary functions of a calyx. Then an internode is developed between the calyx and corolla. But the presence of this internode, long as it is, should no more prevent our assigning to the calyx its proper name, than does the slight internode existing between the calyx and corolla of *Lychnis diurna*.

Great Malvern. H. ST. A. ALDER.

## "The Darwinian Society."

I WOULD call Mr. White's attention to the fact that the name of this Society is not "The Darwinian Society," but "The Edinburgh University Darwinian Society"—a name which, considering Darwin's connection with the University and with a similar Society here, I think we are quite entitled to assume.

JOHN S. FLETT,
Secretary.

University of Edinburgh,
November 24.

## SOME NOTES ON THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION.[1]

### VI.

*The Frankfort Motor and the Lauffen Dynamo.*

IN all the motors described in Part V. the magnetism of the stationary iron ring is being rapidly reversed, while that of the moving interior varies at a rate which is equal to only the difference between the speeds of the rotatory magnetic field and the rotating central portion of the motor. This difference is always comparatively small in a well-designed multiphase motor, even when loaded, and becomes practically nought for light loads. Hence we may regard a multiphase motor as roughly one in which the magnetism of the rotating iron interior remains unchanged relatively to the iron itself, while that of the stationary iron ring varies rapidly.

Now whenever the magnetism of iron is being rapidly reversed, there is loss of power; the magnitude of the loss, for a given rate of reversal and quality of iron, depending on the intensity of the magnetization and the mass of the iron acted on. And, as the length of the lines of force in the outer stationary iron ring of the multiphase motor is necessarily longer than in the interior rotating portion, Mr. Dobrowolski concluded that less power would be wasted if he inverted the functions of the stationary and rotating parts, sending the multiphase alternate currents round the interior rotating laminated iron drum, and attaching the short-circuited conductors, in which currents are induced by the rotating magnetic field, to the *inside* of the stationary laminated iron ring, so as to form a kind of short-circuited Siemens armature turned inside out.

The preceding conclusion is undoubtedly correct if it be certain that *the smaller density of the lines of force in the stationary ring do not more than compensate for the increased length of their path*, a point to which we venture to think Mr. Dobrowolski has not given sufficient attention when coming to this decision to turn the multiphase motor inside out.

However, be that as it may, Fig. 32 shows the multiphase motor of 100 horse-power nominal, which the considerations described in this and the previous article led Mr. Dobrowolski to construct for being worked at Frankfort by a portion of the power generated at Lauffen 109 miles away.

To lead the currents coming along the mains to the rotating interior of the motor, three rubbing contacts must be employed; indeed, six contacts become necessary if we desire to be able to couple up the coils on the motor in open or closed circuits (Figs. 20 and 24, pp. 56 and 57)—an arrangement provided for in the Frankfort motor

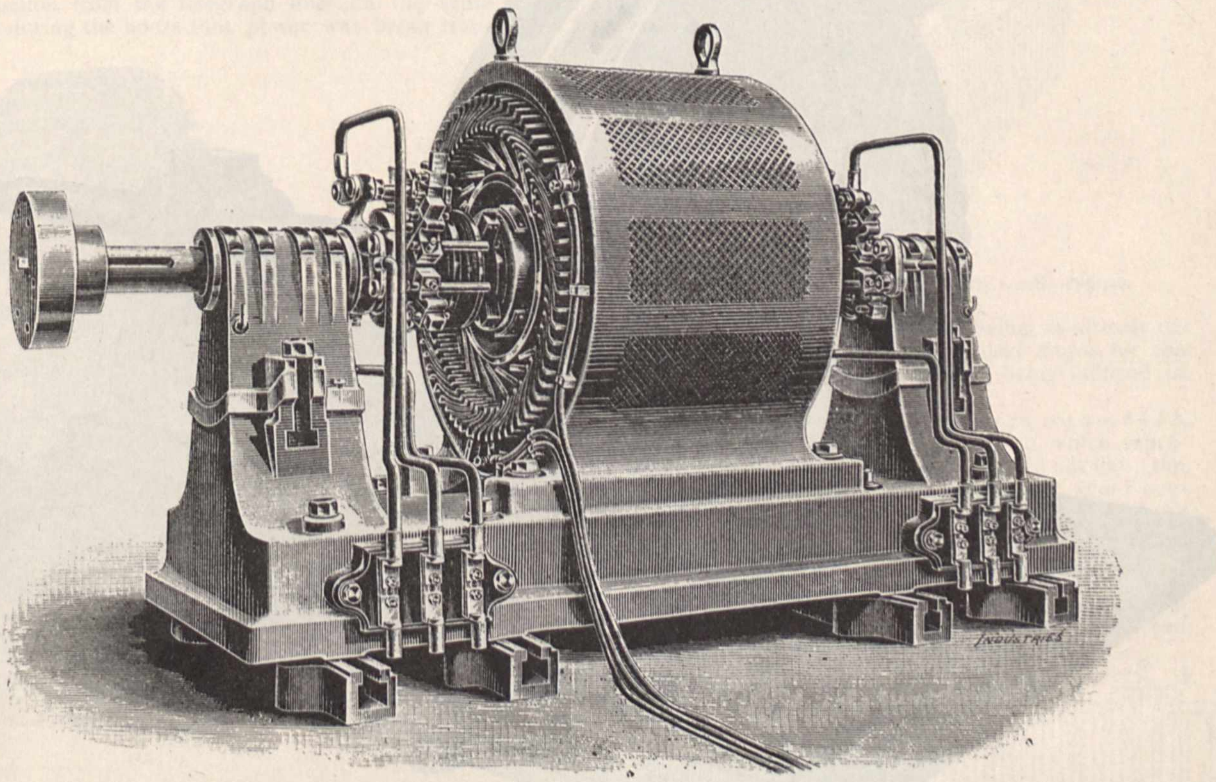

FIG. 32.—The Frankfort 100 horse-power rotatory current motor.

(Fig. 32). The great simplicity of the original Ferraris' motor is thus abandoned, but, although this would be disadvantageous in the case of small motors, where simplicity and freedom from sparking are all-important, the change is not so serious in a large motor, like that shown in Fig. 32, since high efficiency, and therefore small waste of power, combined with relatively small first cost, are the main things to be aimed at in large motors.

Another reason why the application of rubbing contacts to a large rotatory-field motor is less objectionable than might at first sight appear arises from the fact that, even if the motor were constructed in one of the original forms shown in the preceding article, it would be necessary to employ rubbing contacts for a totally different reason, viz. to introduce resistance, at the moment of starting the motor, into the circuits which carry the currents induced by the rotating magnetic field. Whereas, if these currents be induced in conductors attached to the stationary ring,

[1] Concluded from p. 60.

such a resistance can be introduced without extra rubbing contacts; and it is for the purpose of introducing this resistance into these stationary circuits that the three wires, trailing on the ground in Fig. 32, are seen attached to the conductors attached inside the stationary part of the motor.

The necessity, at starting the motor, for increasing the resistance of the conductors carrying the induced currents will appear from the following consideration. When the motor (Fig. 32) is running at full speed under a light load, the interior part rotates at such a rate—relatively to the frequency of alternation of the currents in the main wires—that the magnetic field is practically stationary, just as it is in an ordinary direct current motor. But at the start, the interior laminated iron drum is only moving slowly, while the currents flowing in the conductors attached to it are alternating rapidly, hence the magnetic field is rotating rapidly, and powerful currents are induced in the stationary conductors, so powerful, in fact, as to produce a magnetic field which seriously distorts that produced by the main alternating currents. In fact, there is the same antagonism of magnetic fields that occurs with a direct current motor, if the armature field be very powerful in comparison with that of the field magnet, and if the lead of the brushes be adjusted so as to cause the fields to oppose one another; and it is to avoid this result that M. Dobrowolski introduces a liquid resistance into the circuits of the stationary conductors of his large motors while the motor is getting up speed.

We have hitherto spoken of the conductors on the rotating part as being wound on the outside of a laminated iron drum, and those on the stationary part as being wound on the inner surface of a laminated iron ring; but, as a matter of fact, in the large Frankfort motor both sets are composed of copper rods, insulated in asbestos tubes, and slipped into holes punched out of the iron close to the periphery. This burying of the copper bars to a small depth inside the iron has been adopted because it has been found that the generation of Foucault currents in the thick bars can in this way be more effectively prevented than by following the method usually adopted with bar armatures, which consists in moulding each conductor out of stranded copper wire with the various wires composing the strand partially insulated from one another.

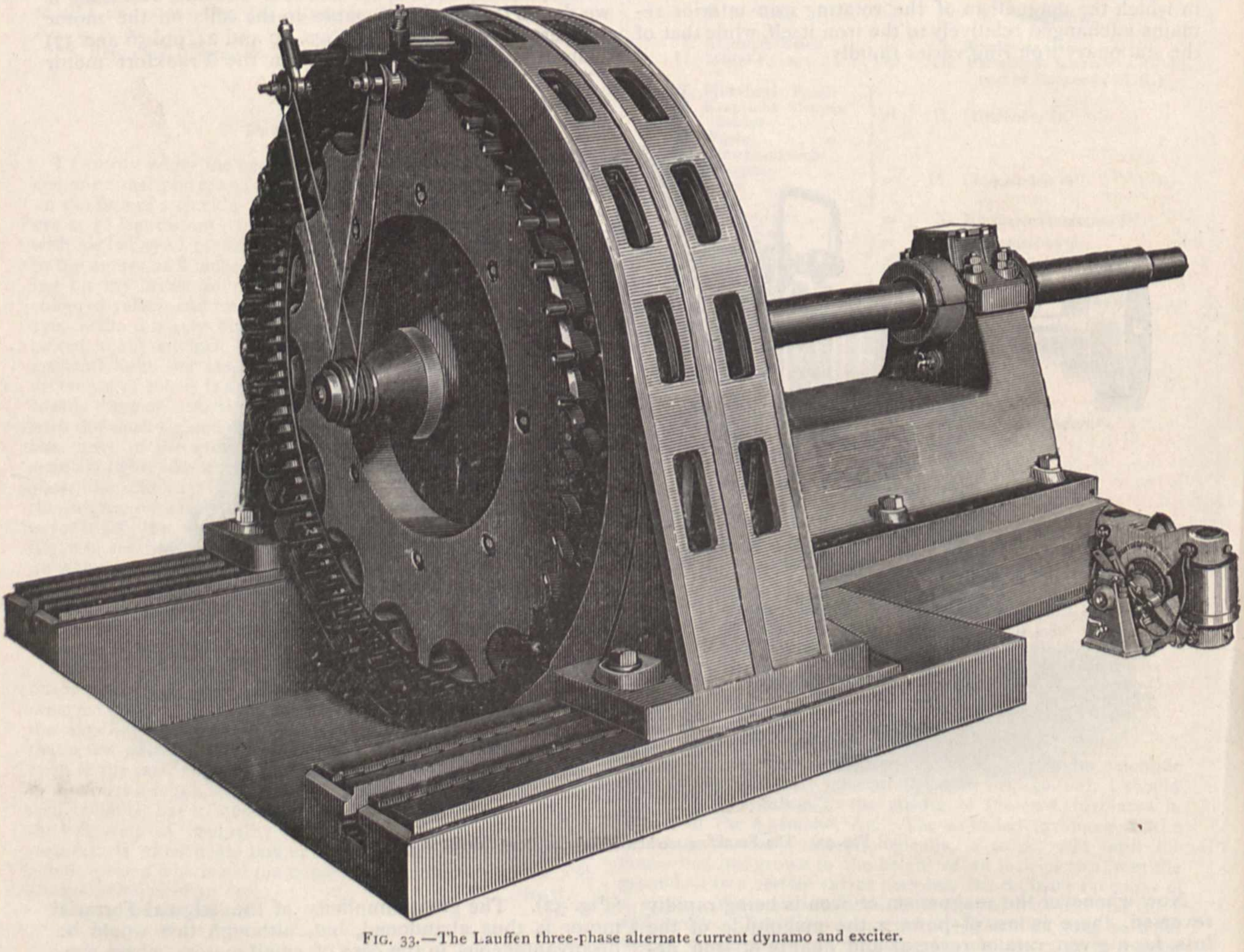

Fig. 33.—The Lauffen three-phase alternate current dynamo and exciter.

No tests have yet been published of the power and efficiency of this machine, but the smoothness with which it ran, pumping up water for the artificial waterfall in the Frankfort Exhibition, and the absence of the roar audible with some alternate current machines, and even of the rhythmical hum noticeable with the best alternate current motors, were very striking.

In the last article it was proved that if three harmonic alternating currents of the same periodic time and maximum amplitude, but differing by 120° in phase, flowed in three wires, A, B, C (Figs. 20, 21, 22), each current was at any moment algebraically equal to the sum of the other two. To test, therefore, whether the currents flowing in the three parallel wires between Lauffen and Frankfort fulfilled this condition, we had merely to find out whether any current was induced in a neighbouring telegraph wire which was sufficiently far away as to be practically at the same distance from each of the Lauffen-Frankfort wires.

Between Frankfort and Hanau the power wires are carried on one side of a broad railway, and for some eight or nine miles the telegraph wires run on the other side; the telegraph wires for the remainder of the distance between Frankfort and Hanau following quite a different route. If one of these telegraph wires were put to earth at Frankfort and at Hanau, and if a telephone were placed in the circuit, a confused chattering of telegraph instruments was always heard in this telephone, due to induction from the telegraph lines on the same posts. But during the hours that power was being transmitted

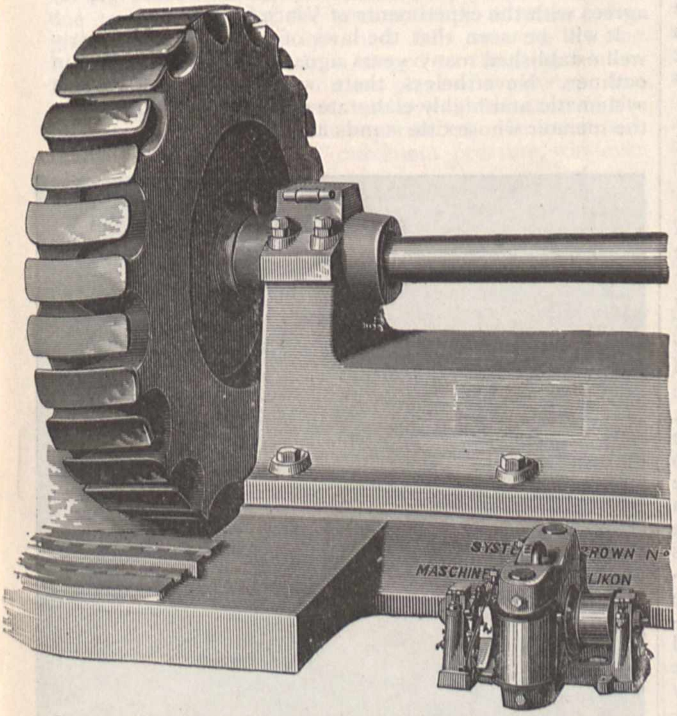

FIG. 34.—Field magnet of the Lauffen three-phase alternate current dynamo.

through the wires on the other side of the broad railway a rhythmical hum could be detected superimposed on the confused babel of telegraph signals, proving that the three alternate currents were either not truly sine currents, or that their phase difference was not accurately 120°.

To generate the three-phase current at Lauffen, the extremely compact dynamo shown in Fig. 33 was designed by Mr. Brown, and constructed at the Oerlikon Works, near Zurich. The armature is wound with three distinct circuits, each arranged to give 1400 amperes at a potential difference of 50 volts, so that the dynamo can develop 300 horse-power. To avoid, as far as possible, rubbing contacts, the armature remains stationary and the field magnet revolves; while by the employment of 32 poles a frequency of 40 complete alternations per second can be obtained in each circuit when the field magnet only makes 150 revolutions per minute.

For examining the interior, the armature, which forms the outside shell of the machine, can be withdrawn sideways, leaving the field magnet in position, as seen in Fig. 34. Each of the 32 flat-looking plates round the circumference of the field-magnet is a magnetic pole, the poles being alternately north and south. This result is attained by constructing the field magnet in the ingenious manner shown in Fig. 35, the coil which carries the direct current to magnetize this field magnet being wound in the circumferential channel seen in section in Fig. 35.

The armature bars, 96 in number, are constructed of copper rods 29 mm. in diameter, insulated in asbestos tubes, and slipped through holes (parallel to the axis of rotation) punched out of the laminated iron ring which composes the armature core; this burying of the con-

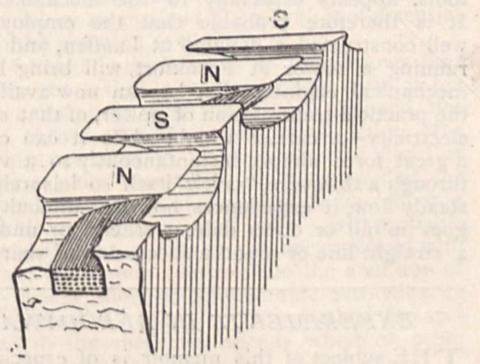


FIG. 35.—Section of the field magnet of the Lauffen dynamo.

ductors to a small depth in the iron being, as already explained in the case of the Dobrowolski motor, for the purpose of avoiding Foucault currents being induced in the thick copper bars.

A portion of the three separate windings, *a a a a*, *b b b b*, *c c c c*, on the armature is shown in Fig. 36, which represents a bit of the circumferential part laid out flat; the dotted rectangles indicate the poles, and to avoid confusion the armature bars, parallel to the length of the poles, are drawn longer in proportion than they really are.

In order that the electromotive forces induced in all the up and down bars of any one of the windings *a a a a* in Fig. 36 should help one another, the distance between

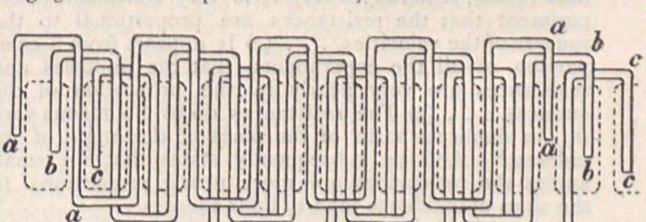


FIG. 36.—Portion of the armature-winding of the Lauffen three-phase alternate current dynamo.

any up and the adjacent down conductor of the same winding must be equal to the distance between two adjacent poles—that is, to 1/32 of the circumference of the armature; and in order that the electromotive force generated by the winding *b b b b* should differ in phase by 120° from the electromotive force generated in the winding *a a a a*, the distance between an up bar of the winding *a a a a* and the following up bar of the winding *b b b b* must be two-thirds of the distance between the centres of two adjacent poles—that is, must be 1/48 of the circumference of the armature. Similarly, an up bar of the winding *c c c c* must be behind the preceding up bar of the winding *c c c c* by 1/48 of the circumference of the armature.

The exciting current is led into the field magnet by the novel employment of the two endless metallic cords seen to the left of Fig. 33, which saves the necessity of using a standard to carry contact brushes, and the smallness of the power spent in exciting the field magnet, compared with the power developed by the machine, is seen from the dwarf-like character of the direct current exciting dynamo in Figs. 33 and 34.[1]

This three-phase alternate current dynamo of Mr. Brown's, on account of the simplicity and solidity of its design, the slow speed of its rotation, and the entire absence of the experimental makeshifts which are supposed to be characteristic of an electrician, but which are in reality evidences of the rapid development of his tools, appeals especially to the mechanical engineer. It is therefore probable that the employment of so well constructed a dynamo at Lauffen, and so smoothly running a motor at Frankfort, will bring home to the mechanical engineer that he can now avail himself, for the practical transmission of power, of that silent carrier electricity—a carrier which, while it can communicate a great force almost instantaneously to a vast distance through a thin wire, travels itself so leisurely that, in its steady flow, it experiences no extra difficulty whether it goes up hill or down dale, overhead or underground, in a straight line or round a succession of sharp corners.

## *EXPERIMENTS IN AËRODYNAMICS.*[2]

THE subject of this memoir is of especial interest at the present time, when the skill of a distinguished inventor is understood to be engaged in attacking the many practical difficulties which lie in the way of artificial flight upon a large scale. For a long time the resistance of fluids formed an unsatisfactory chapter in our treatises on hydrodynamics. According to the early suggestions of Newton, the resistances are (1) proportional to the surfaces of the solid bodies acted upon, to the densities of the fluids, and to the squares of the velocities; while (2) "the direct impulse of a fluid on a plane surface is to its absolute oblique impulse on the same surface as the square of the radius to the square of the sine of the angle of incidence." The author of the work[3] from which these words are quoted, in comparing the above statements with the experimental results available in his time (1822), remarks:—"(1) It is very consonant to experiment that the resistances are proportional to the squares of the velocities. . . . (2) It appears from a comparison of all the experiments, that the impulses and resistances are very nearly in the proportion of the surfaces. . . . (3) The resistances do by no means vary in the duplicate ratio of the sines of the angle of incidence." And he subsequently states that for small angles the resistances are more nearly proportional to the sines of incidence than to their squares.

It is probable that the law of velocity tended to support in men's minds the law of the square of the sine. For, if both be admitted, it follows that the resistance, normal to the surface, experienced by a plane when immersed in a stream of fluid, depends only upon the *component* of the velocity perpendicular to the surface. That the effect should be independent of the component parallel to the plane seems plausible, inasmuch as this component, *if it existed alone*, would exercise no pressure; but that such a view is entirely erroneous has been long recognized by practical men, especially by those concerned in navigation.

From the law of the simple sine, enunciated by Robison, it follows at once that the pressure upon a lamina exposed perpendicularly to a stream may be increased *to any extent* by imparting to the lamina a sufficiently high velocity *in its own plane*. The immense importance of this principle was clearly recognized by Mr. Wenham in his valuable paper upon flight;[1] and a few years later the whole subject was discussed by the greatest authority upon such matters, the late Mr. W. Froude, with characteristic insight and lucidity.[2]

The theoretical problem of determining the resistance from the first principles of hydrodynamics is not free from difficulty, even in the case of two dimensions, where a long rectangular lamina is exposed obliquely to a stream whose direction is perpendicular to the longer sides. The formula[3] resulting from the theory of Kirchhoff, viz.

$$\frac{\pi \sin \alpha}{4 + \pi \sin \alpha} \rho V^2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $\rho$ is the density of the fluid, and V is the total velocity of the stream flowing at the angle $\alpha$ with the plane of the lamina, shows that when $\alpha$ is small the resistance is nearly proportional to sin $\alpha$. Moreover, (1) agrees with the experiments of Vince.[4]

It will be seen that the laws of resistance were fairly well established many years ago, at least in their main outlines. Nevertheless, there was ample room for the systematic and highly elaborate experiments recorded in the memoir whose title stands at the head of this article.

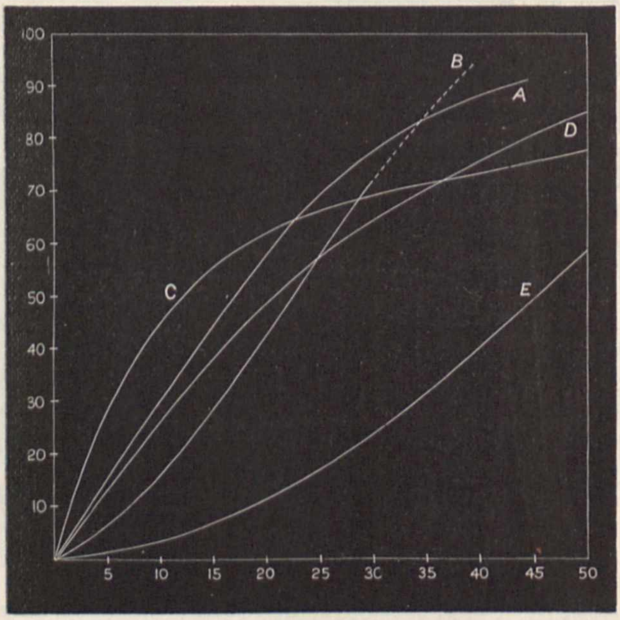


FIG. 1.

The work appears to have been executed with the skill and thoroughness which would naturally be expected of the author, and will doubtless prove of great service to those engaged upon these matters. The scanty reference to previous knowledge, which Prof. Langley holds out some promise of extending in subsequent publications, makes it rather difficult to pick out the points of greatest novelty. The main problem is, of course, the law of obliquity, and this is attacked with two distinct forms of apparatus. The general character of the results, exhibited graphically on p. 62, will be made apparent from the accompanying reproduction, in which are added a curve D,

[1] We are indebted to *Industries* and the *Electrician* for some of the illustrations used in this article.

[2] "Experiments in Aërodynamics." By S. P. Langley. "Smithsonian Contributions to Knowledge." (Washington, 1891.)

[3] "System of Mechanical Philosophy," by John Robison, vol. ii., 1822.

[1] Report of Aëronautical Society for 1866.

[2] Proc. Inst. Civ. Eng., 1871 (discussion upon a paper by Sir F. Knowles).

[3] See *Phil. Mag.*, December 1876. Also Basset's "Hydrodynamics," vol. i. p. 131.

[4] Phil. Trans., 1798.

corresponding to (1), and E, representing the law of $\sin^2 a$. In each case the abscissa is the angle $a$, and the ordinate is the normal pressure, expressed as a percentage of that experienced when $a = 90°$. Of Prof. Langley's curves, A relates to a *square* plane 12 inches × 12 inches, B to a rectangle 6 × 24 inches, and C to a rectangle 30 × 4·8 inches, the leading edge (perpendicular to the stream) being in each case specified first, so that the theoretical curve D corresponds most nearly to C. It will be seen at a glance that at small angles the pressure is enormously greater than according to the law of $\sin^2 a$. The differences between A, B, C, anticipated in a general manner by Wenham and Froude, are of great interest. They demonstrate that in proportion to area a long narrow wing is more efficient as a support than a short wide one, and that in a very marked degree.

Up to a certain point there is no difficulty in giving a theoretical account of these features. When a rectangular lamina is exposed perpendicularly, there is one point, *i.e.* the centre, at which the velocity of the stream is annulled. At this point the pressure attains the full amount, $\frac{1}{2}\rho V^2$, due to the velocity of the stream, while at every other point the pressure is less, and falls to zero at the boundary. If the lamina is sloped to the stream, as in B and C, there is still a median plane of symmetry; and at one point in this plane, but now in advance of the centre, the full pressure is experienced. In strictness, there is only one point of maximum pressure, whatever may be the proportions of the lamina. But if the rectangle be very elongated, there is practically a great difference in this respect according to the manner of presentation, although the small angle $a$ be preserved unchanged. For when the long edges are perpendiculer to the stream (C), the motion is nearly in two dimensions, and the region of nearly maximum pressure extends over most of the length. But the case is obviously quite different when it is the short dimension that is perpendicular to the stream, for then along the greater part of the length there is rapid flow, and consequently small pressure.

It will naturally be asked whether any explanation can be offered of the divergence of C from the theoretical curve D. This is a point well worthy of further experiment. It seems probable that the cause lies in the suction operative, as the result of friction, at the back of the lamina. That the suction is a reality may be proved without much difficulty by using a hollow lamina, AB (Fig. 2), whose interior is connected with a manometer.

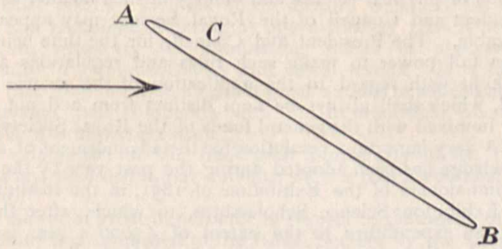


FIG. 2.

If there be a small perforation at any point C, the manometer indicates the pressure, positive or negative, exercised at this point, when the apparatus is exposed to a blast of air.

When once the law of obliquities is known, the problem of aërial maintenance presents no further theoretical difficulty. It was successfully treated many years ago by Penaud,[1] and somewhat later by Froude, whose interesting letters, written shortly before his death, have recently been published.[2] In perhaps the simplest form of the question the level is supposed to be maintained with the aid, *e.g.*, of screw propulsion, the necessary maintenance being secured by an aëroplane slightly tilted ($a$) upwards in front. The work required to be expended in order to maintain a given weight depends upon the area of plane, the inclination, and the speed. Penaud's results show that, *if skin friction could be neglected*, the necessary work might be diminished indefinitely, even with a given area of wing. For this purpose, it would only be necessary to increase the speed and correspondingly to diminish $a$. But when skin friction is taken into account, the work can only be reduced to a minimum, and to do this with with a given area of wing requires a definite (large) velocity, and a definite (small) inclination. The accurate determination of the tangential, as well as of the normal, force experienced by an inclined plane is thus of essential importance in the question of flight.

[1] See Report of Aëronautical Society for 1876.
[2] Edinburgh Proceedings, R. E. Froude, 1891.

The work of Penaud seems to be so little known that it has been thought desirable to recapitulate some of his theoretical conclusions. But we owe to Penaud not merely sound theory, but the actual construction of a successful flying machine, in which horizontal flight is maintained by a screw propeller. In these models the energy is stored by means of stretched india-rubber, a method available only upon a small scale. It is probable that the principle of the rocket might be employed with advantage; and even upon a large scale the abolition of all machinery would allow of considerable extravagance in the use of explosive material. This method is especially adapted to the very high speeds which on other grounds are most suitable.

In the chapter on "The Plane Dropper," some striking experiments are described, illustrating the effect of a forward movement in retarding the fall of a horizontal plane. Prof. Langley seems hardly to recognize that there is nothing really distinctive in this arrangement when he says:—

"It is, of course, an entirely familiar observation that we can support an inclined plane by moving it laterally, deriving our support in this case from the upward component of pressure derived from the wind of advance; but, so far as I am aware, this problem of the velocity of fall of a horizontal plane moving horizontally in the air has never been worked out theoretically or determined experimentally, and I believe that the experimental investigation whose results I am now to present is new."

But, apart from the complications which attend the establishment of a uniform *régime*, there is no essential difference between the two cases. The hydrodynamical forces depend only upon the magnitude of the relative velocity and upon the inclination of this relative velocity to the plane. All else is a question merely of ordinary elementary mechanics.

It is interesting to note that Prof. Langley's experience has led him to take a favourable view of the practicability of flight upon a large scale Such was also the opinion of Penaud, who (in 1876) expresses his conviction "that, in the future more or less distant, science will construct a light motor that will enable us to solve the problem of aviation." But sufficient maintaining power is not the only requisite; and it is probable that difficulties connected with stability, and with safe alighting at the termination of the adventure, will exercise to the utmost the skill of our inventors.

RAYLEIGH.

## PRELIMINARY NOTICE OF A NEW BRANCHIATE OLIGOCHÆTE.

THE term "Annélides abranches sétigères," applied by Cuvier to the group which included the terrestrial and fresh-water Annelids, now known as the Oligochæta, is no longer applicable to that group. Several Oligochæta have been described as possessing gills, which, though for the most part differing in structure from the gills of the Polychæta, must be branchial in function. The most remarkable instance hitherto known is *Alma nilotica*, lately redescribed by Levinsen (*Vidensk. Meddel. naturh. For. Kjöbnhavn*, 1889) under the name of *Digitibranchus niloticus*. The posterior segments of this Annelid possess four to five branchial processes on each side of the dorsal middle line of the body. It cannot yet be regarded as an absolute certainty that this species belongs to the Oligochæta at all; but in any case processes of the body-wall, containing each a capillary loop, and therefore probably branchial in function, have been recently described by Prof. A. G. Bourne (*Quart. Journ. Micr. Sci.*, vol. xxxi.) in a new genus of Naids—*Chætobranchus*. These processes, though doubtless branchial in function, are rather suggestive of the parapodia of marine Annelids, since they inclose, partially or entirely, the dorsal setæ. I have lately had the opportunity of examining this Annelid, through the kindness of Mr. Sowerby. The "*Victoria regia* tank" at the Botanical Society's Gardens, which produced the celebrated "Fresh-water Medusa" and other remarkable forms, furnished me with *Chætobranchus*, and with a new and interesting form of branchiate Oligochæte, which I propose to call *Branchiura Sowerbii*.

In its general aspect this worm recalls a *Tubifex*; the setæ, in their shape, and in their arrangement, resemble those of *Tubifex*. But here the resemblance ends. The last sixty segments or so of the body (there are from 130–170 segments altogether) are provided with a paired series of long tentacle-like processes—a pair to each segment—lying the middle ventral and dorsal lines; towards the middle of the series these processes exceed in length the diameter of the body; anteriorly and posteriorly they diminish, and finally become mere wart-like protuberances. The processes in question are supplied with blood from the main vascular trunks. They are in continual movement, each branchia moving quite independently by means of the contraction of simple muscular fibres. The writhing movements, as well as the structure of these organs, is much like that of the tentacles and cirri of certain Polychæta. Apart from the individual contractions of these branchiæ, the tail end of the worm perpetually jerks from side to side, particularly when the creature is in any way disturbed. I do not know whether the worm usually rests in the mud with the tail protruding and waving about, like many other aquatic Oligochæta; but it is probable, from the limitation of the branchiæ to the tail end, that it does. I found three specimens, which were slowly crawling about.

Frank E. Beddard.

## THE ANNIVERSARY OF THE ROYAL SOCIETY.

MONDAY being St. Andrew's Day, the anniversary meeting of the Royal Society was held in their apartments in Burlington House. The report of the auditors of the Treasurer's accounts having been read, and the Secretary having read the list of those Fellows who have been elected and those who have died since the last anniversary, the President, Sir William Thomson, delivered the anniversary address. After an account of the scientific work of those Fellows who had died within the year, the President proceeded:—

"The Royal Society, since the last anniversary meeting, has been, as always, active both in the proceedings of its ordinary meetings, which have been full of scientific interest, and in the conduct of the important affairs committed to its Council. During the past year nineteen memoirs have been published in the Philosophical Transactions, containing a total of 1020 pages and 60 plates. Of the Proceedings, six numbers have been issued, containing 893 pages. Of the large number of papers which have been published in the Proceedings two-thirds are on the physics and dynamics of dead matter and one-third on biological subjects.

"As stated by Sir George Stokes in his Presidential Address at the last anniversary meeting, a revision of the whole body of the Statutes of the Royal Society had been entered upon, a Committee had recently reported to the Council, and its report had been left to the new Council then entering on office to take such action in the matter as might be judged proper. The Council now concluding its term of office has accordingly given much time to the subject, and has completed the work of re-enacting the Statutes with such amendments as have seemed desirable. The only questions upon which there was effective difference of opinion were those connected with the election of Fellows, which were referred to by Sir George Stokes as having elicited considerable difference of opinion in the reporting Committee. The Council, after much anxious consideration, resolved to make no change of the existing Statutes in this respect.

"There have been no changes during the past session in the constitution of the staff employed in the Offices and Library; but in the Catalogue Department, two lady assistants and two copyists have been engaged to work under the superintendence of Miss Chambers, who succeeded in July of last year to the post rendered vacant by the death of the late Mr. Holt, and who continues to give every satisfaction in the discharge of her duties.

"In January of the present year a communication was received from our Fellow, Prof. G. S. Brady, intimating that his brother, the late Mr. Henry Bowman Brady, whose decease I have already mentioned, had bequeathed to the Society all his books and papers relating to the Protozoa, with the recommendation that they should be kept together as a distinct collection. In case this recommendation should be adopted, a further bequest of £300 was made, the interest or principal or both to be applied, at the discretion of the Council, to the purchase of works on the same or kindred subjects, to be added to the collection. The Council have accepted both these bequests, and a case marked with an engraved plate has been set aside in the Library for the accommodation of the Brady collection.

"His Excellency Robert Halliday Gunning, M.D., LL.D., F.R.S.E., who in 1887 founded certain scholarships and prizes for the promotion of original scientific work and proficiency in scientific education in connection with the Royal Society of Edinburgh, the University of Edinburgh, and other institutions in that city, called the Victoria Jubilee Prizes, desires to institute foundations of a similar kind in London. He has accordingly given to the Royal Society a sum of £1000, to be ultimately invested in such manner as the President and Council, in their absolute and uncontrolled discretion, may think fit, and to be held in trust always for the purpose of forming a fund the annual income of which shall be applied triennially towards the promotion of physical science and biology in such manner as to the President and Council of the Royal Society may appear most desirable. The President and Council, for the time being, are given full power to make such rules and regulations as they think fit with regard to the application of the income of the fund, which shall always be kept distinct from and not in any way immixed with the general funds of the Royal Society.

"A very important resolution for the advancement of natural knowledge has been adopted during the past year by the Royal Commissioners of the Exhibition of 1851, in the institution of the Exhibition Science Scholarships, to which, after the first year, an expenditure to the extent of £5000 a year is to be devoted. Sixteen appointments have already been made to scholarships of £150, to be held for two years, with possible renewal for a third year. The Commissioners require of each candidate for an appointment satisfactory evidence of proficiency in a three years' course of University or high class College study, and of capacity for experimental work. To the tenure of each scholarship the duty is assigned of advancing science by experimental work in physics, mechanics, chemistry, or any application of science tending to benefit our national industries.

"A Committee of the British Association, appointed for the purpose of reporting on the best means of comparing and reducing observations on terrestrial magnetism, has strongly recommended the re-establishment of a magnetic Observatory at the Cape of Good Hope. A conference on the subject was held between the Committee and Dr. Gill, the Astronomer-Royal of the Cape of Good Hope, last June, during his recent visit to

England, which has resulted in an application to the Admiralty to carry this recommendation into practical effect in connection with the astronomical Observatory of the Cape of Good Hope (belonging to the Admiralty). This application is at present under the consideration of the Admiralty.

"A fundamental investigation in astronomy, of great importance in respect to the primary observational work of astronomical Observatories, and of exceeding interest in connection with tidal, meteorological, and geological observations and speculations, has been definitively entered upon during the past year, and has already given substantial results of a most promising character. The International Geodetic Union, at its last meeting in the autumn of 1890, on the motion of Prof. Foerster, of Berlin, resolved to send an astronomical expedition to Honolulu, which is within 9° of the opposite meridian to Berlin (171° west from Berlin), for the purpose of making a twelve months' series of observations on latitude corresponding to twelve months' analogous observations to be made in the Royal Observatory, Berlin. Accordingly, Dr. Marcuse went from Berlin, and, along with Mr. Preston, sent by the Coast and Geodetic Survey Department of the United States, began making latitude observations in Honolulu about the beginning of June. In a letter from Prof. Foerster, received a few weeks ago, he tells me that he has already received from Honolulu a first instalment of several hundred determinations of latitude, made during a first three months of the proposed year of observations; and that, in comparing these results with the corresponding results of the Berlin Observatory, he finds beyond doubt that in these three months the latitude increased in Berlin by one-third of a second, and decreased in Honolulu by almost exactly the same amount. Thus, we have decisive demonstration that motion, relatively to the earth, of the earth's instantaneous axis of rotation is the cause of variations of latitude which had been observed in Berlin, Greenwich, and other great Observatories, and which could not be wholly attributed to errors of observation. This, Prof. Foerster remarks, gives observational proof of a dynamical conclusion contained in my Presidential Address to Section A of the British Association at Glasgow, in 1876, to the effect that irregular movements of the earth's axis to the extent of half a second may be produced by the temporary changes of sea-level due to meteorological causes.

"It is proposed that four permanent stations for regular and continued observations of latitude, at places of approximately equal latitude, and on meridians approximately 90° apart, should be established under the auspices of the International Geodetic Union. The reason for this is that a change in the instantaneous axis of rotation in the direction perpendicular to the meridian of any one place would not alter its latitude, but would alter the latitude of a place 90° from it in longitude by an amount equal to the angular change of the position of the axis. Thus two stations in meridians differing by 90° would theoretically suffice, by observations of latitude, to determine the changes in the position of the instantaneous axis; but differential results, such as those already obtained between Berlin and Honolulu, differing by approximately 180° in longitude, are necessary for eliminating errors of observation sufficiently to give satisfactory and useful results. It is to be hoped that England, and all other great nations in which science is cultivated, will co-operate with the International Geodetic Union in this important work."

The celebration of the hundredth anniversary of the birth of Faraday, recorded in our columns at the time, was next referred to.

"A matter of great importance in respect to the health of the community was submitted to the Royal Society by the London County Council, in a letter of date May 1, 1891, asking for information and suggesting investigation regarding the vitality of microscopic pathogenic organisms in large bodies of water, such as rivers which are sources of water-supply and which are exposed to contamination. After some correspondence, it was agreed, between the County Council and the Council of the Royal Society, to enter upon an investigation, the expense of which was to be defrayed partly by the London County Council and partly by the Royal Society out of the Government Grant for Scientific Research. When we consider how much of disease and death is due to contaminated water, we must feel that it is scarcely possible to over-estimate the vital importance of the proposed investigation. Let us hope that the alliance between the London County Council and the Royal Society, for this great work, may be successful in bringing out practically useful results.

*Prof. Stanislao Cannizzaro (Copley Medal).*

"Stanislao Cannizzaro, Senator of Italy, and Professor of Chemistry in the University of Rome, has rendered invaluable service to the philosophy of modern chemical science. The work of Avogadro, in 1811, and afterwards that of Ampère, had already thrown much light on the relative weights of the molecules of elementary bodies, and on the proportion in which those weights enter into chemical combination. But it is to Cannizzaro that we owe the completion of what they had left unfinished He pointed out the all-important difference, hitherto overlooked, between molecular and atomic weights, and showed (1) how the atomic weights of the elements contained in a volatile compound can be deduced from the molecular weights of such compounds; (2) how the atomic weights of the elements the vapour-densities of whose compounds were unknown can be ascertained by help of their specific heats. By these investigations the series of atomic weights of the elements, the most important of all chemical constants, and the relation which these weights bear to the molecular weights of the elements, have been placed on the firm basis on which they have ever since rested. It is to Cannizzaro that science is indebted for this fundamental discovery, and it is this which it is proposed to recognize by the award of the Copley Medal.

*Prof. Charles Lapworth, F.R.S. (Royal Medal).*

"Prof. Lapworth is the author of some of the most original and suggestive papers which have appeared in the geological literature of this country for the last twenty years. Special reference may be made to his researches on graptolites, and to his patient investigation by these means of the exceedingly complicated structure of the Silurian uplands of the south of Scotland. He has been able not only to supply the key which has given the solution of the stratigraphical difficulties of that region, but also to furnish theoretical geology with an array of new facts from which to philosophize as to the mechanism of mountain-making. Of not less importance are his detailed studies of the structure of the North-west Highlands, and his demonstration of the true order of stratigraphical sequence in that region of complex disturbance. As a stratigraphist he has attained the highest rank, and he has likewise made himself a chief palæontological authority on the structure and distribution of the Graptolitidæ. For some years past he has been engaged in a laborious study of the Silurian and Cambrian rocks of the middle of England, the detailed publication of which is awaited with much interest by geologists.

*Prof. Rücker, F.R.S. (Royal Medal).*

"In conjunction with Prof. Reinold, Prof. Rücker carried out an important series of researches (extending over ten years) on the electric resistance and other physical properties of liquid films, in the course of which the fact was established that the black part of a soap film in equilibrium has a uniform or nearly uniform thickness of 11 or 12 micromillimetres, and that there is an abrupt augmentation across its border to a thickness of about 30 or 40 micromillimetres in passing to the coloured portions. This, considered in connection with the well-known sudden opening out of the little black areas in an ordinary soap-bubble, proves a minimum of surface-tension for some thickness between 10 and 50 micromillimetres, which in the ordinary soap-bubble, unmodified by Reinold and Rücker's electric current, is temporarily balanced in virtue of the abrupt change of thickness, a proposition of fundamental importance in the molecular theory, implying the existence of molecular heterogeneousness.

"In theoretical calculations connected with the compounding of dynamos and motors to produce constant potential difference, constant current, or constant speed, electricians did not see their way to obtain results of a sufficiently simple character to be of use in practice, if they employed a function of the current which fairly represented the magnetism. They were, therefore, compelled to assume in such calculations that the magnetism was a linear function of the current, although it was well known that this was very far from being true when the current was large. Prof. Rücker, however, developed a simple method of attacking such problems, and showed how the magnetic saturation of the iron might be taken into account, and a comprehensive solution of the general problem of compounding dynamos and motors obtained in a workable form. Prof. Rücker's paper containing his investigation, and which will be found in the Proceedings of the Physical Society, is a most valuable contribution to the theory of direct-current dynamos and motors.

"Prof. Rücker has, with the co-operation of Prof. Thorpe, completed a magnetic survey of the British Isles (1884–89), which, independently of its great value in investigations of the distribution of the earth's magnetism, and the changes to which it is subject, is specially remarkable for the exhaustive discussion of the observations in reference to regions of local magnetic disturbance, and their relation to the geological constitution of the earth's crust in the neighbourhood. Prof. Rücker has followed up this discussion by a paper on 'The Relation between the Magnetic Permeability of Rocks and Regional Magnetic Disturbances,' read before the Royal Society. The high estimate that has been formed of the value of this magnetic survey is perhaps most easily appreciated from the very large sums that the Government Grant Committee have recommended should be contributed to aid in the completion of this work of international importance.

*Prof. Victor Meyer (Davy Medal).*

"Prof. Victor Meyer, formerly the successor of Wöhler at Göttingen, and who now occupies the chair of Bunsen at Heidelberg, is eminent as an original worker and discoverer in almost every branch of chemical science. His methods of determining the vapour-densities of substances have been of the greatest service to chemists, not only as convenient and generally applicable modes of ascertaining atomic and molecular weights, but also as serving to throw light on the molecular constitution of elements and compounds under varying conditions of temperature and pressure. A striking example of the value of these methods is seen in their application by their author to the study of the molecular dissociation of the element iodine—one of the most masterly investigations of recent years, and which is universally recognized as of the very highest significance and importance. Not less noteworthy are Victor Meyer's services to organic chemistry. His work on the nitroso-bodies, and his brilliant discovery of thiophene, the initial member of a class of substances hitherto unknown, his subsequent synthetical formation of it, and the remarkable series of researches on its derivatives, in part carried out with the aid of his pupils, stamp him as an investigator of exceptional power and distinction."

The Society next proceeded to elect the Officers and Council for the ensuing year. The following is a list of those elected:—President: Sir William Thomson. Treasurer: John Evans. Secretaries: Prof. Michael Foster, The Lord Rayleigh. Foreign Secretary: Sir Archibald Geikie. Other Members of the Council: Captain William de Wiveleslie Abney, William Thomas Blanford, Prof. Alexander Crum Brown, Prof. George Carey Foster, James Whitbread Lee Glaisher, Frederick Ducane Godman, John Hopkinson, Prof. George Downing Liveing, Prof. Joseph Norman Lockyer, Prof. Arthur Milnes Marshall, Philip Henry Pye-Smith, William Chandler Roberts-Austen, Prof. Edward Albert Schäfer, Sir George Gabriel Stokes, Bart., Prof. Sydney Howard Vines, General James Thomas Walker.

In the evening the Fellows and their friends dined together at the Whitehall Rooms, Hôtel Métropole. The company numbered over 230. The chair was occupied by the President.

After the loyal toasts, Dr. John Evans proposed "Her Majesty's Ministers and the Members of the Legislature," a toast to which Sir J. Fergusson responded.

In response to "The Royal Society," proposed by Mr. Forwood, M.P. (who referred to the fact that Sir William Thomson's discoveries "had rendered it possible to steer vessels on our fog-bound coast with an accuracy never before attained to"), the President said that the Royal Society had always been distinguished for the promotion of investigations leading to such results as Mr. Forwood had named. In illustrating this, he spoke of the history of the construction of the sextant and the development of the dynamical theory of the trade winds. A curious interest attached to some of the earlier Transactions of the Society, such as a paper which attributed the trade winds to the breathing of a certain plant, which turned to the sun and blew its breath after it. The earlier pages of the Transactions were full of chronometers and of the work leading up to the invention which gained the reward of £10,000. Excellent work was done with the grant of £4000 administered by this and allied Societies; and he believed its future achievements would at least equal those of the past. The next fifty years would probably produce, in the science of dead matter, and in the science of living matter too, discoveries compared with which those of the last 300 years would ultimately appear to be small indeed.

The President proposed the health of "The Medallists," and spoke in eulogistic terms of the services in respect of which the medals had been awarded.

The Italian Ambassador briefly responded in the name of Prof. Stanislao Cannizzaro.

Prof. Rücker, in responding for the other medallists, said:—

Islanders as we were, the Royal Society prided itself on the fact that some of its medals could be awarded to distinguished scientific workers outside these islands. This year no less than four foreign Fellowships and two medals testified to our respect and esteem for colleagues abroad. We respected them for many things—for the thoroughness with which they grasped all that the scientific movement meant and involved; for the foresight and courage with which—beginning at the beginning—they had provided for their students laboratories and workshops such as no English lad could enter at home. We respected them for the sound educational methods which had led them to use these appliances, so as to point the student to the research laboratory rather than to the examination room as the goal of his ambition. We respected them because these methods have produced their natural results, and year by year a crop of new scientific facts was reaped not only from the laboratories of their Colleges, but from the workshops of their manufacturers. We respected and esteemed most of all the men who had thus led or who were thus leading their countrymen aright—veterans, such as Cannizzaro, who, amid the turmoil in which the foundations of modern Italy were laid, found time to lay the foundations of chemistry anew; investigators, such as Victor Meyer, who, when Bunsen retired from the laboratory where so many English chemists learnt or perfected their art, was judged by all to be a worthy successor to Bunsen himself. While fully admitting that we had something to learn from the work and methods of our foreign colleagues, we might claim that our progress had lately quickened where at one time we notoriously lagged behind. In the multiplication of centres of scientific work, Scotland was formerly the only part of these islands which compared with Germany. This was no longer so. Every large town in England and Wales and the chief towns of Ireland had now University Colleges. Their scale was modest indeed when compared with what a paternal Government was providing for Strasburg, or a democracy for Zürich; but they were full of intellectual energy and of scientific work. Hardly a month passed without the publication of papers on researches conducted in the laboratories of some of them. Almost every year they were represented in the list of Fellows newly elected into the Society. Out of the last eight recipients of the Royal Medals, five had, either as learners or as teachers, or, in turn, in both capacities, spent many years within the walls of one or other of our provincial Colleges. But he must not be understood as claiming for English science only that it was making good confessed educational deficiencies. There were sciences which, either in their origin or their development, were peculiarly our own. One of these was geology. Crowded up between our four seas was an epitome of the past history of the world such as he believed no other country possessed in an equally small area. Thus geologists were a natural product of our soil. But there was one particular in which he thought the President, more than most, would appreciate Prof. Lapworth's audacity and success. Though a Southerner, he had made a foray into Scotland, and had returned laden with spoil. It was true that he, too, had crossed the border, and he deeply regretted that he must confess that his track was marked by disturbances: but speaking for Prof. Lapworth and on his behalf—though without consulting him—he must admit that his offences were venial and that he was most to blame. He turned the most fundamental institution of Scotland—its geological strata—upside down. There were only two ways of meeting an invader or an innovator such as this—with steel or with gold. They must confute him with the pen or reward him with a medal. The Council had chosen the better part of valour, and he was sure the Society did not question their discretion. With regard to himself, there was one remark that he must make. In some of the principal researches in which he had been engaged he had worked with colleagues. While, therefore, thanking the Society for the honour they had been pleased to confer upon him, he was, perhaps, not wrong in thinking that Dr. Thorpe and Prof. Reinold, who had received many marks of appreciation from the Royal, the Physical, and the Chemical Societies, were receiving further, though less direct, recognition from the Royal Society to-day. Apart from all minor questions, the distinguishing characteristic of this meeting was the bringing together of men who were working at different branches of science. These gatherings, and those which in the summer take place during the meetings of the British Association, were, he thought, good for all of them. They checked that scientific particularism which in the cultivation of a subject of study ignored the culture of the student. They reminded them that they were all co-operating to one common end—the promotion of natural knowledge. The very speech that he was making bore testimony to this fact, for were it otherwise the President would not have called upon an Englishman to reply for our absent foreign medallists, or a physicist to return thanks for honours bestowed on experts in geology and chemistry. It was only because he himself believed that there was between scientific men a similarity of aim and object, and a community of ideas, which underlay all superficial differences, that he ventured to undertake the task of expressing the thanks in which, he was sure, one and all of the medallists most heartily joined.

Prof. Dyer proposed "The Visitors," associating with the toast the name of the Greek Minister. He said:—

The association appeared to him a peculiarly happy one. The other day he came across a striking statement of Sir Henry Maine's—"Except the blind forces of Nature, nothing moves in this world which is not Greek in its origin." The former influence they could in this Society give some account of. But the latter he regarded with a certain scientific scepticism. Yet he was not disposed to dispute its validity. We still commenced our often arduous mathematical studies with Greek geometry, and he could not gainsay those who thought that the influence of the counsels of Plato, and of the precepts of Aristotle, was unexhausted. In art Greece remained unsurpassed and unsurpassable. Some might say that if scientific men had their way they would extinguish Greek studies. This was far from the truth. In this Society they rejoiced in those exact studies which recreated the literature and life of the past.

The Greek Minister, in replying, said:—

He had always been of opinion that those who were intrusted with the duty of representing their respective Governments in this country, need confine their watchfulness and activity neither to political nor to social circles alone. They had before them a wide and unrivalled field in which to study the benefits accruing to a whole community—to the Government itself—from the efforts of private individuals, when guided by public zeal and devotion to science; and he thought no more striking example of such benefits could be instanced than the results of the labours of this, the most ancient and most illustrious of learned Societies. It might be said to have been born with the first dawn of scientific research in England; it had remained its stronghold in times of political trouble and change; it numbered in its long muster roll all those names which had bequeathed an undying fame to British science; it had worked out and solved, for the benefit of the State, scientific questions which were elsewhere delegated to official departments alone; its catalogue of scientific papers was a monument of the world-wide grasp of its subjects. That the achievements of this Society should have been continuous and ever increasing in importance for close upon 250 years was characteristic of British public zeal and tenacity of purpose. But what was especially instructive was the ardour with which such work was prosecuted, not only by those whose pursuit was science, but by those especially who, like the illustrious statesman at the head of Her Majesty's Government, being independent by fortune and already great by birth and political achievements, yet contributed powerfully to the advancement of science. It was at symposia such as this that the philosophers of ancient Greece laid down those great truths of science which had found amongst this Society such ardent apostles and such illustrious expounders. The guests on whose behalf he responded, and he himself, expressed sincere acknowledgments for the honour they had done them that night.

The company then separated.

## *NOTES.*

A MEETING of the honorary council of advice in connection with the Crystal Palace Electrical Exhibition, which is to be opened on January 1 next, was held last week at the Mansion House. The Lord Mayor presided. Mr. Gardner, the secretary of the Crystal Palace Company, read the report of the directors, in which they referred to the Electrical Exhibition at the Palace in 1881, and to the enormous strides which had since been made in the industry. The Exhibition of 1881 was recognized as the pioneer of electrical engineering in this country, and it was confidently believed that the Exhibition of 1892 would be remembered in history "as showing that the infant Electra has grown to years of maturity, and is capable of further aiding science, commerce, and the world at large." The space available had been over-applied for, and every section of the industry would be well represented. Invitations would be issued to public bodies throughout the United Kingdom to visit the Exhibition, where the various systems of electric lighting would be on view, and in this direction alone very great saving of expense to the authorities would be effected, and other advantages must, the directors believed, also accrue. On the motion of Mr. W. H. Preece, the following gentlemen were appointed to act as a committee of experts in connection with the exhibits: Profs. W. Grylls Adams, W. E. Ayrton, W. Crookes, D. E. Hughes, A. B. W. Kennedy, J. Perry, and Silvanus Thompson, Major P. Cardew, Sir J. N. Douglass, Mr. W. B. Esson, Mr. Gisbert Kapp, and Mr. Preece.

ON Friday last a portrait of Sir William Thomson, by Mr. Herkomer, was presented to the University of Glasgow. A number of friends subscribed for it, to signalize Sir William's election to the office of President of the Royal Society. The presentation was made by Mr. Balfour, the Lord Rector of the University, who spoke eloquently of Sir William Thomson's great career as a man of science and an inventor. A replica of the portrait was presented to Lady Thomson.

THE Egyptian Government has asked the Caisse de la Dette for £50,000 from the general reserve fund on behalf of the Antiquities Department. The Cairo correspondent of the *Times* says that before granting so large a sum the Caisse will probably require the appointment of a Commission to study the purposes for which it is to be used. It is hoped that searching investigation will be made into the management of the department generally.

IT is expected that Australia will be well represented at the Chicago Exposition. Exhibits connected with education, minerals, forestry, and especially wool are to be sent. About fifty wool growers and wool brokers met lately at Sydney, and decided to despatch a very extensive collective exhibit of wools.

WE have to note a change in the form of the publications ssued by the Meteorological Department of India. From January 1 last, the Annual Reports on the Meteorology of India, which have hitherto been issued about fourteen months after the termination of the year to which they referred, have been replaced by a Monthly Weather Review, the first four parts of which have been received. It is hoped that, when the arrangements are complete, these reports will be published from six to eight weeks after current date. The materials used are the morning observations taken at 136 stations, and afternoon observations taken at 82 stations; and eventually, a monthly summary of rainfall observations will be given for about 2500 stations. The text contains full discussions of the chief features of the weather, under each of the principal elements, illustrated by maps showing the mean distribution of the conditions for the month, and the variations from the mean. The report for January also contains a brief review of the meteorology of the year 1890, in which it is stated that conditions were very abnormal in Upper India, and very favourable for a severe winter in the hill districts, and for abundant rain in the plain districts, while the snowfall in the Kashmir Himalayas and Afghanistan during November and December was abnormally heavy. Temperature was steadily below the average in Northern India, but was excessive in the peninsula.

The *Abhandlungen* of the Royal Prussian Meteorological Institute (Bd. i., No. 4, 1891) contain the first part of a treatise on the climate of Berlin, referring to rainfall and thunderstorms. Berlin possesses a long series of observations, commencing with the beginning of the eighteenth century, but in this investigation some of the earlier observations have not been used. The subjects treated of are:—(1) The amount of rainfall, the annual mean being given as 23 inches. The extreme values varied from 14·26 inches in 1887 to 30 inches in 1882. The wettest months were June and July, yielding together 24 per cent. of the annual amount. (2) Rain frequency. The average number of days on which more than 0·08 inch fell was 152. The months of greatest rainfall frequency were November and December. (3) Hail and soft hail (*Graupel*). The former occurred on 2 to 3 days and the latter on 3 to 4 days in each year, and mostly in the months May, June, and July. (4) Snow. A Berlin winter numbers on an average 33 snowy days. The distribution according to months is very curious: snow does not occur most frequently in the coldest months; it falls as often in March as in December. It lies on the ground 49 days on an average. (5) Intensity of rainfall. Daily falls of more than 2 inches are quite exceptional, and of 1½ inches are not frequent. The greatest fall was 1·86 inches in 1½ hours. (6) Wet and dry periods. Attention is more particularly given to periods of short duration; wet periods of five or more days are fewer than dry periods of similar length; the former average 7·5 and the latter 13·2 per year. (7) Thunderstorms. Berlin enjoys comparative immunity from thunderstorms, as they occur on an average on only 15 days in the year, about half of them being in June and July. This valuable discussion has been carried out by Prof. G. Hellmann.

The common type of cyclone weather is sometimes materially altered by orographical conditions. This is the case, *e.g.*, at Turin, as recently shown by Signor Rizzo (in a paper to the Academy there). He cites thirty-three cases in the last twenty-five years, which indicate the general course of the weather when a cyclone passes over Northern or Central Europe. After fall of the barometer, with strong west wind, the sky clears, the temperature rises considerably, and the moisture of the air diminishes. This is explained by the influence of the Alps. The strong west wind is forced up the mountain-range, so that its aqueous vapour is condensed, and falls as rain and snow on the western slopes and summit. After crossing the ridge, it descends, and, having parted with its moisture, appears as a warm dry wind (thus forming an unusual feature in cyclones).

The temperature of the rivers of Central Europe has been recently investigated by Herr Forster, of the Society of Geographers at Vienna University; the monthly and annual means being obtained from thirty-one stations. He distinguishes (with reference to river and air temperature) the following types:—(*a*) Glacier rivers. These are always warmer than the air in winter, and much cooler in summer; on the average of the year, they are about 1° colder. (*b*) Glacier rivers modified by lakes, and rivers from lakes in general. These are, except in spring, warmer than the air, therefore warmer on the annual average. (*c*) Mountain rivers. Like glacier rivers, these are warmer in winter and cooler in summer than the air, but the difference, especially in summer, is not nearly so great; so that, on the average of the year, it is approximately 0°. (*d*) Flat country rivers. Their temperature is, throughout the year, higher than that of the air; and the annual average difference is over 1°. Sometimes a different relation between river and air temperature is found in the upper part of a river and in the lower, and transition-types occur between those above indicated.

The Bahama Islands are soon to be connected with the general telegraphic system of Great Britain and the world. A submarine cable about 200 miles long will be laid from a point about five miles from Nassau, New Providence, to a point about the same distance from Jupiter Inlet, on the south-east coast of Florida. The cable has been designed for the Government of the colony by Mr. W. H. Preece. It will be insulated with gutta-percha, and is being manufactured by Messrs. W. T. Henley and Co. It will be laid in January or February next by the steamer *Westmeath*, belonging to that firm. As the Western Union Telegraphic Company's Floridan lines do not at present run so far south as Jupiter Inlet, the station at the American terminus of the cable will be in charge of the officers of the United States Weather Bureau, who will transmit the messages to the Western Union Company's system over their private line. Traffic between England and the Bahamas will thus pass through the Atlantic cables.

At a meeting held at Aylesbury on Saturday it was resolved, on the motion of Sir Harry Verney, that it was desirable to establish a County Museum for Bucks, and that an executive committee should be appointed to take the necessary measures. Letters from various eminent men of science were read at the meeting. Prof. Flower, writing from the British Museum, pointed out that a good County Museum, well arranged, neat, and attractive, might be the means of conveying instruction and giving interest and pleasure to thousands, and that money, time, knowledge, and sympathetic care must be expended upon it. Prof. Alfred Newton, of Magdalene College, Cambridge, said that the proposal to establish a Museum for Buckinghamshire had his best wishes. He advocated the founding of a maintenance fund, which should be vested in trustees. Prof. Green, of the University Museum, Oxford, contended that in the proposed Museum care should be taken for the proper selection of objects, the primary end being to illustrate the district in which it existed.

Dr. Ermling contributes to the current number of *Globus* an interesting paper on the Nurhagi of Sardinia. There are said to be more than 3000 of these prehistoric buildings in the island. They are almost all in fertile districts, and are built in groups which are separated from one another by wide and generally barren spaces. According to many archæologists, the Nurhagi were tombs; but the late Canon Spano, in his "Memoria sopra i Nurhagi di Sardegna," published in 1854, contended that they were dwellings and places of refuge, and this view is accepted by Dr. Ermling. In a trench closed with asphalte, under the ruins of a Nurhage near Teti, various bronze statuettes, swords, spear-heads, and axes were discovered lately by shepherds. These treasures are now in the museum of M. Gouin, a Frenchman, in Cagliari. Some of the objects have been analyzed, and it has been found that the chemical composition of the bronze statuettes is not the same as that of the axes. The statuettes consist of copper 90·3, tin 7·4, iron 2·1; the axes, of copper 87·4, tin 12·0, lead 0·5, with traces of iron.

IN the new number of *Petermann's Mitteilungen* Prof. Vambéry has a valuable paper on the geographical nomenclature of Central Asia. He gives a list of names, his spelling of which may safely be accepted as authoritative. The list is to be extended on some future occasion.

AT a recent meeting of the Field Naturalists' Club, Victoria, Mr. C. G. W. Officer read a paper on supposed human footprints on Æolian rocks at Warrnambool. In introducing the subject, Mr. Officer described in detail the formation and nature of the sand dunes, and their connection with the underlying strata, as shown by the similarity of the stone now being quarried there. From an analysis of the stone made by Mr. Avery, of Queen's College, it appears that it contains about 94 per cent. of carbonate of lime. Last December a slab was discovered in one of the quarries bearing impressions which suggested that they were made by human beings. This slab was secured by Mr. Archibald, and placed in the Warrnambool Museum. The determination of the age of the rocks is of importance, and from the evidence of subsidence and elevation which have probably taken place since the impressions were made, Mr. Officer is of opinion that a considerable lapse of time has occurred since the rocks were laid down, and he suggests that the impressions were made by two individuals sitting close together and somewhat obliquely to each other. Mr. J. Dennant, discussing the paper, pointed out that it was necessary to be very guarded in accepting any but the strongest evidence on such questions as those relating to the supposed footprints. Amongst limestone rocks it was well known that mimetic forms were common. In the Æolian rocks of Cape Bridgewater occurred the so-called fossil forest, which the casual observer could hardly be persuaded to believe was an accidental resemblance, and nothing more. At the same time Mr. Dennant congratulated Mr. Officer on having produced an interesting and highly suggestive paper. The rocks were well described, and whether his conclusions concerning the impressions were accepted or not, he had succeeded in drawing renewed attention to one of the most striking formations in Victoria.

MR. J. B. TYRRELL, Ottawa, of the Canadian Geological Survey, has spent the last two summers in examining the shores of Lake Winnipeg, Winnipegosis, and Manitoba; and he has issued a few notes on his observations, in advance of a more detailed report to the Survey. Speaking of striation, Mr. Tyrrell refers to many distinct and characteristic glacial striæ which show that during the Ice Age a great glacier, or lobe of the Laurentide glacier, moved south-south-eastward across the lacustral plains of Manitoba, along the valley of Red River to the height of land, and onward to near Des Moines, Iowa, sending off branches up the valleys of Swan and Red Deer rivers. The total length of this glacier or lobe, from the north end of Lake Winnipeg to its extreme southern limit in Iowa, would be about 850 miles. With reference to moraines, Mr. Tyrrell says the highest at present known in Northern Manitoba are those capping the summits of portions of the Duck and Riding Mountains, with altitudes of 2500 to 2700 feet above the sea, or 1800 to 2000 feet above the surface of Lake Winnipeg. On the shores and islands of Lake Winnipeg a distinct moraine has lately been recognized. In a section on shore lines Mr. Tyrrell describes Kettle Hill, on the south side of Swan Lake, as one of the most interesting monuments of ancient shore phenomena in the whole district. Swan Lake has an estimated elevation of 27 feet above Lake Winnipegosis, or 855 feet above the sea; and the hill, which appears to have been largely composed of Dakota sandstone, rises 275 feet above it. On the face of this hill are five distinct terraces, representing six different shore lines, at elevations of 920, 955, 995, 1015, 1070 feet above the sea, those at 955, 995, and 1070 being most strongly marked, the last being the most distinct.

MR. D. MORRIS, Assistant Director of the Royal Gardens, Kew, lately sent to the *Entomologist's Monthly Magazine* for identification specimens of a Coccid, supposed by him to be *Icerya Purchasi*, received from St. Helena. They were found there on some rose bushes which had been imported from the Cape of Good Hope. In a note in the new number of the *Entomologist's Monthly Magazine*, Mr. J. W. Douglas says there is not the least doubt that the specimens received are females of *Icerya Purchasi*; and he adds that if the brood of which they are samples be not extirpated at once by burning all the plants on which they exist, so as to destroy all eggs and young larvæ, they will form the beginning of a pest that must be intensely serious in such a small island. The probability is that they were introduced as eggs or larvæ, and so escaped observation.

THE fourth volume of the entomological publication issued by the Russian Grand-Duke Nicholas, under the title of "Mémoires sur les Lépidoptères, rédigés par N. M. Romanoff," contains a very valuable work by M. Gr. Grum-Grshimailo—"Le Pamir et sa Faune lépidoptérologique," with twenty-one coloured plates and a map of the Pamir. Besides its special entomological part, the work contains some interesting deductions concerning the geological history of the Pamir. The author came to the conclusion, confirmed afterwards on geological grounds by Prof. Mushketoff, that during the Miocene period the Pamir plateau and Tibet formed a continent which rose isolated above the great Tertiary sea. It was separated at that time from the Tian-Shan Mountains, but seems to have been connected with the Altai Mountains, probably through the Bei-Shan highlands. The hypothesis seems probable on orographical grounds as well—the Pamir and the Altai Mountains belonging to the great plateau of Asia of which the Great Altai is one of the border ridges, while the Tian-Shan belongs to the series of ridges parallel to the border ridges, and is separated from them by deep valleys, which must have been filled by the waters of a Tertiary sea. The same structure may be observed in East Siberia also.

LISTS of the Macro-Lepidoptera and birds of Winchester and the vicinity have been compiled by members of the Winchester College Natural History Society, and have now been published together in the form of a pamphlet. The compilers have evidently taken great care to be accurate, and their work cannot fail to be of service to students of natural history in the locality. Mr. A. W. S. Fisher, who signs the preface to the list of Lepidoptera, points out that it contains 425 species, which have all occurred within six miles of Winchester College. Mr. S. A. Davies, in the list of birds, indicates by an asterisk the cases in which the birds recorded have been bred within a radius of a quarter of a mile of the College. In most cases, Mr. Davies himself has found the nest within the last three years.

ACCORDING to Hering's views, the optical stimulation-value, or "valence," of a coloured radiation, is made up of one white and one or two colour valences (the greater the former, the less the saturation). And he has sought to measure the white valences; one useful means lying in the fact that to an eye kept long in the dark all coloured rays of a certain low intensity seem colourless, but of very different brightness. Hering has lately had an opportunity of taking measurements on a person having sight, but totally blind to colours (a very rare case). This was a music-teacher, twenty years of age. The experiments (described in *Pflüger's Archiv*) brought out the fact that the spectrum of the totally colour-blind is considerably shortened; in this case it began about 665 $\mu$, and ceased about 420 $\mu$. The greatest intensity was in the green. Further, it appeared that all coloured radiations had the same relations of brightness to each other for the adapted normal eye as for the eye of the colour-blind person. With any two spectral lights, again, an equality of sensation could be produced in this person, when a suitable ratio of intensities was established; and when the two different colours, which seemed equal to the colour-blind, were examined with the normal eye (adapted to darkness), it was found that these two colours had equal white valences. In general, the brightness-curve of the spectrum of the colour-blind had the same course as the curve of white valences for the normal eye. These facts are regarded as a strong confirmation of the author's views.

THE Morgue in Paris now has a medico-legal institute attached to it, with courses of lectures, &c. The need of frigorific apparatus has been long felt, and in a recent competition for the supply of it, the arrangement proposed by MM. Mignon and Rouart (Carré's system) has been selected by a Committee, and will be worked out. According to the Report (*Bulletin de la Soc. d'Encouragement*), Prof. Brouardel imposed three conditions: (1) to submit bodies, on arrival, to a temperature of $-15°$ to $-20°$ C. (this on account of bad conductivity and slowness of freezing internally, also the advanced state of decomposition often met with); (2) to take them into a room with temperature varying between $-4°$ and $-1°$; and (3) to keep ten bodies at a temperature of $-4°$. Further, vibration was to be avoided, and the air kept still. The method of Carré, it is known, depends on changes in an aqueous solution of ammoniacal gas, the gas being driven off by heat, liquefied by its pressure, vaporized, and absorbed by water. Chloride of calcium is used to transmit the cold; this liquid passing through pipes in the wooden walls of a freezing cell, into which the body is pushed on a carriage. Ten hours is enough for the largest body: it becomes hard as wood. The after-process is easier. Bodies can be kept thus more than eight months, though decomposition had begun before freezing. When an autopsy is to be made, the body is put into a case which is heated with gas burners, and afterwards it may be relegated to the frozen state to be kept longer. To keep bodies at $-2°$ in a hall, for exhibition to the public, presented special difficulties. How these were overcome may be learned from the above-mentioned Report.

THE new number of the Journal of the Marine Biological Association of the United Kingdom (new series, vol. ii., No. 2) opens with the Council's report for 1890–91 and the Director's report. The weather was extremely unfavourable for continuous and systematic dredging; nevertheless the boats of the Laboratory were constantly employed on every suitable day, and a considerable amount of material was collected. The preservation of specimens has been much more carefully attended to than formerly. One man now devotes almost his entire time to this work. The following are the other contents of the present number:—The egg and larva of *Callionymus lyra*, by J. T. Cunningham (with plate v.); experiments on the production of artificial baits, by Frank Hughes; the rate of growth of some sea fishes and their distribution at different ages, by J. T. Cunningham; on some Ascidians from the Isle of Wight—a study in variation and nomenclature, by Walter Garstang (with plates vi. and vii.); on the development of *Palinurus vulgaris*, the rock lobster or sea crayfish, by J. T. Cunningham (with plates viii. and ix.); the reproduction and growth of the pilchard, by J. T. Cunningham (with plate x.); the distribution of *Crystallogobius nilssonii*, by J. T. Cunningham; physical investigations, preliminary paper, by H. N. Dickson (with plate xi.); notes on meteorological observations at Plymouth, by H. N. Dickson; notes on the herring, long-line, and pilchard fisheries of Plymouth (continued), by William Roach, Associate Member; note on a British Cephalopod—*Illex eblanæ* (Ball), by William E. Hoyle; notes and memoranda.

PROF. KAUFMANN, of Liége, has issued a useful "Student" Guide" to the Liége School of Mines and Engineering, the Montefiore Electro-technical Institute, and the principal engineering firms in Liége and the environs. He quotes from an official report by Mr. Vice-Consul Menzies a statement to the effect that the advantages offered by Liége from an educational point of view do not seem to be duly appreciated in the United Kingdom. While the youth of almost all the other European nations are fairly, and in some instances largely, represented at the Liége University, the British students rarely number more than five or six at a time, and sometimes not even that.

A "Handy List of Books on Mines and Mining" has been compiled and published by Mr. H. E. Haferkorn, of the Milwaukee Public Library. He describes it as an alphabetical reference catalogue, arranged under authors and subjects, and including analytical references to the contents of important works.

MESSRS. WHITTAKER AND CO. have issued the fourth edition of the "Working and Management of an English Railway," by George Finlay. In June 1890 the author read a paper at the Royal United Service Institution, on the transport of troops by rail within the United Kingdom. The substance of this paper he has embodied in the chapter on railways as a means of defence. To the present edition he has also added, as an appendix, a lecture (with emendations) delivered at the Society of Arts, on modern improvements of facilities in railway travelling.

MESSRS. WHITTAKER AND CO. have in the press a second edition of Dr. A. B. Griffiths's "Treatise on Manures." It is a little more than two years since the work appeared. Fifty pages of new matter have been added.

THE third edition of "Electricity, treated Experimentally for the Use of Schools and Students," by Linnæus Cumming, has been published by Messrs. Longmans, Green, and Co. The author has made such additions and alterations as seemed necessary to bring the book up to date.

A NEW edition of Prof. A. Humboldt Sexton's "Elementary Inorganic Chemistry" (Blackie and Son) has been issued. To meet the alterations in the syllabus of the Science and Art Department, the author has recast the part dealing with qualitative analysis.

THE American Association for the Advancement of Science has just issued the Proceedings of its meeting (the thirty-ninth) held at Indianapolis, Indiana, in August 1890.

PART 38 of Cassell's "New Popular Educator" has been published. Besides the illustrations in the text, it includes a good map of Spain and Portugal.

THE second series of lectures given by the Sunday Lecture Society begins on Sunday afternoon, December 6, in St. George's Hall, Langham Place, at 4 p.m., when Mr. Eric S. Bruce will lecture on "Fogs and their Prevention." Lectures will subsequently be given by Prof. J. F. Blake, Prof. Vivian B. Lewes, Prof. Percy Frankland, F.R.S., Dr. Benjamin W. Richardson, F.R.S., Mr. Whitworth Wallis, and Mr. Willmott Dixon.

THE additions to the Zoological Society's Gardens during the past week include a Barbary Mouse (*Mus barbarus*) from Barbary, a Chinese Blue Magpie (*Cyanopolius cyanus*) from China, two Brown Thrushes (*Turdus leucomelas*) from South America, purchased; a Vulpine Phalanger (*Phalangista vulpina*), born in the Gardens.

## OUR ASTRONOMICAL COLUMN.

MOTION OF STARS IN THE LINE OF SIGHT.—In a paper read before the Royal Society in January 1890, Prof. Lockyer described a new method of observing spectra of stars and nebulæ which did away with errors due to the collimator of the spectroscope not being exactly in the optic axis of the telescope owing to the flexure of the telescope tube. It consisted in using a siderostat to reflect the light of the body under observation to a vertical object-glass, whence it was converged on the slit of a fixed spectroscope. By this means perfect stability can be secured. This method has been utilized by M. Deslandres, of Paris Observatory, for the photographic determination of the displacements of lines in stellar spectra due to motion in the line of sight (*Comptes rendus*, November 23). Comparison spark spectra are taken above and below the spectrum of the star, and the difference of position of the lines common to the star and these spectra afterwards measured. The elements used for comparison are iron, calcium, and hydrogen, and the best results have been obtained with the first of the three. The lines in a spectrum of Sirius, taken on March 3, 1891, in this manner, exhibited a displacement which corresponded to a velocity of recession relative to the earth of 19 kilometres per second. But as the earth's motion towards Sirius at the time of observation was 20·2 kilometres per second, the approach of the star to the sun was 1·2 kilometres per second. The results indicate that considerable advantage is to be gained by the use of the siderostat in the study of the radial motions of stars.

THE VARIATION OF LATITUDE.—Some determinations of the latitude of Cambridge, U.S., made in 1884–85 exhibited a progressive variation, from which, however, no inference was drawn at the time. The stars observed were contained between $-5^{\circ}$ and $+5^{\circ}$ of declination, but a subsequent discussion based on more northerly stars ($+5^{\circ}$ to $+50^{\circ}$) gave an exactly corresponding variation in latitude. Mr. S. C. Chandler, in the *Astronomical Journal*, No. 248, gives the results of a recent examination of his values, and from the curve connecting the residuals finds the minimum latitude to have been on September 1, 1884, and the maximum latitude on May 1, 1885, with a range of about $0''\cdot7$.

PHOTOGRAPHY OF THE ECLIPSED MOON.—During the lunar eclipse of November 15, M. Courty, of Bordeaux Observatory, took four photographs of the moon after it had entered the earth's shadow. The exposure given was about two minutes, and the disk of the moon could be easily traced on the negatives, and on some positives presented with a note by M. Rayet to the Paris Academy on November 23. M. Janssen remarked that by photographing the eclipsed moon and the full moon on the same plate, and determining the times of exposure necessary to obtain both images of equal density, a good idea of the relation of the light intensity in the two cases may be obtained.

## PROPOSALS FOR A SCHEME OF CO-OPERATIVE OBSERVATION OF THE SO-CALLED LUMINOUS CLOUDS.

SINCE 1885 curious cloud formations have been seen on summer nights in both the northern and southern hemispheres, in evident connection with those phenomena which followed the great volcanic eruption at Krakatão. The intense brightness of these formations, considering the position of the sun, denoted that they were situated very far above the earth's surface. Probably these clouds consisted of erupted particles thrown to a very great height and there illuminated on summer nights by the sun.

These cloud-like formations, commonly called luminous clouds, are extremely interesting, both on account of the extraordinary height at which they have for years been moving above the surface of the earth (more than 80 kilometres) and of the movements themselves. A very important point about these clouds is that they are—so far as we yet know—visible in each hemisphere only in the summer. It is the more important that these phenomena should be carefully and widely observed, since it is believed that they are gradually breaking up, so that probably in a very few years no distinct traces of them may remain (see also O. Jesse on so-called luminous clouds, in the journal *Himmel und Erde*, vol. i. p. 263).

Photographic results of the researches of O. Jesse are given in Part xl. of the Transactions of the Berlin Academy of Science for 1890, and Part xxvi. for 1891. It is very desirable that such photographs should be taken in as many different localities as possible, because from them we get the surest basis for consideration of the situation and movements of the clouds. But valuable aid may be given by the co-operation of numerous observers in various regions of the earth without the aid of any apparatus.

The principal points upon which stress is to be laid in this inquiry are:—

(1) By what method can the so-called luminous clouds be most surely distinguished from others, especially from the ordinary cirrus cloud?

Clouds or cloud-like formations which after sunset and before sunrise stand out brightly from the dark ground of the heavens, no earthly or unearthly sources of light being present on the horizon, can only produce this effect by means of their own light or else by light which they receive directly or indirectly from the sun or moon below the horizon.

Cloud-like formations which shine at night by their own light have doubtless been formerly observed above the surface of the earth. To these formations belong not only thunder and lightning clouds, but also some polar light and meteoric phenomena.

But the so-called luminous clouds do not belong to the various species of self-luminous clouds, for finer measurements of their light are wanting, besides which the fact that they are only seen within the zone of twilight proves that the sun below the horizon is the principal source of their light.

It is well known that there are clouds within this twilight zone which resemble high mountain peaks, and which in the first stages of twilight shine in the light of the sun, though the latter is below the horizon of the observer. It is easy to determine the relation between the position of the sun below the horizon, and the height of those layers of atmosphere which receive the sun's light and reflect it.

But the laws which govern the whole course of twilight are modified when the distribution of the sunlight-reflecting particles in the atmosphere is altered to any great extent. If, for instance, numerous minute atoms produced by volcanic eruption or by the breaking up of meteoric bodies find their way into those heights above the earth's surface in which usually the gaseous elements of the atmosphere are present in a very scattered form, it may happen that such a layer, which reflects the sunlight very strongly, may curiously alter the course of the twilight.

So long after sunset as the masses of air beneath such a layer receive direct light from the sun and reflect it, the observer will not distinguish any deviation from the usual course of twilight. But as soon as the further sinking of the setting sun gradually deprives the lower layers of air of the direct light, the higher layer of dust still receiving light from the sun stands out in astonishing brightness, the particles of dust having strong reflecting power, thus giving to the close of twilight the curious effect of the sudden appearance of shining clouds on the broad surface of the heavens.

The phenomena of the luminous clouds corresponded when first perceived to the above description. At present they are no longer so strong or so extensive, but only form thin whitish-blue shining veils, similar in form to the so-called cirrus or feather clouds, occupying but a comparatively small part of the floor of the heavens inside the twilight segment, and in our zone mostly near the horizon. Probably, the layers are now so thin that very near and exactly above us they can no longer be seen.

From the above considerations it is clear in what way these clouds differ from those situated nearer to us, and especially from the cirrus clouds floating scarcely more than 13 kilometres above the earth's surface. All these lower clouds appear in the later twilight grey and shadowy on a light ground, because the layers of atmosphere above them are the chief source of the remaining twilight. The luminous clouds differ too in shape and structure from the other kinds of clouds.

We must guard, however, against the error of mistaking cirrus for luminous clouds, when, in exceptional cases, the former look very bright, in consequence of receiving light either directly or indirectly from the moon or other sources. In this case, the question is decided by the relatively high degree of stability in position and form of the very high and distant luminous clouds, as ordinary clouds lie lower and nearer, and show much more rapid changes of position.

(2) When convinced of beholding so-called luminous clouds, to what points shall attention be especially directed, and what simple measurements of place, time, form, &c., shall be carried out in order to aid most usefully in the inquiry?

In answering this question we will first consider those methods of research in which the observer can obtain no instrumental aid, except only a watch, which should be a sufficiently good timekeeper to estimate the time of observation to one minute, when compared with the correct time within eight to twelve hours after the observation.

Such simple observations are the more useful, since it frequently happens that in the well fitted up and prepared stations, observation of the phenomena is prevented by bad weather, or else that the phenomena stretch over too large an extent of the earth's surface to be included in an organized series of observations. The farther the stations are apart, the more valuable are the most simple methods. For instance, in order to get corresponding photographic observations from two stations, 35 kilometres apart, such as Berlin and Nauen, the most rigid exactness, both as to time and place, must be observed.

If, however, observations are taken in East Prussia and in the Rhine province respectively, a from twenty to thirty times larger margin of difference as to time and place can be allowed than in the foregoing case, without in any way lessening the value of the result.

So, if without preparation and instruments to hand an observer believes he beholds luminous clouds, he must not imagine that he can render no service to science by examining them closely, for very possibly the most simple method may, taken in conjunction with other similar observations, prove to be of the greatest service.

It is desirable, too, to look out for luminous clouds at all seasons of the year, though, so far, they have only been seen in summer. In the northern hemisphere they have only been seen from the end of May to the beginning of August, with greatest frequency and brightness in the month of July.

During these weeks, usually two stars are seen simultaneously with the luminous clouds, a star of the first magnitude, Capella, and a star of the same constellation, of the second magnitude, β Aurigæ.

The brighter of the two stars, which is characteristic of summer nights, in the northern horizon, sets towards the end of June soon after eleven, and towards the middle of July before ten, on account of the northerly direction of the meridian, and, in North Germany, at a distance from the horizon of 10 to 12 diameters of the full moon. At almost as great a distance from this bright star, and at a not very different distance from the horizon, the second magnitude star follows towards the west.

By estimating the distances and directions of these two stars, an excellent means is afforded of determining the outlines of a group of luminous clouds. It is only necessary to determine how great the distance of a certain part of the outline of the cloud group is from one or the other star, and in what direction this line lies with regard to one or the other star, or how far the line in question is above or below the prolongation of the connecting line of the two stars. A simple drawing of the course of the outlines and their situation with regard to the two stars is useful, even when it cannot be completed on the spot but must be finished from memory. The time at which the drawing was made should be noted within one half-minute.

If the group of clouds should be so far from the above-mentioned two stars as to make the determinations inexact, it is advisable to determine the outlines of the clouds for a certain time in the following way. Take up a position from which the outlines of houses, trees, &c., can be seen close to the position of the clouds, and fix thus the relative position of these earthly objects to the position of the clouds by a simple drawing, describing the spot from which the observation is made in such a manner that the place occupied by the head of the observer can be found again. The lines drawn from the position of the observer to the outlines of the earthly objects, and the resulting localization of the outline of the clouds in the heavens can then be determined at once by means of simple instruments for measuring angles, or on succeeding nights by the aid of a good star chart.

It is necessary to verify the exact point of time of these observations by comparison of the watch used with the time at a telegraph office, and correction of any errors should be made to the fraction of a minute.

In communicating these observations, the exact place at which they have been made must be accurately described.

Should a complete observation be impossible, owing to the time during which the luminous clouds are visible being too short for careful measurements and drawings or to any other cause, the observer should nevertheless communicate briefly to the Society of Friends of Astronomy and Cosmic Physics that he has seen what he believes from the foregoing considerations to be luminous clouds from a certain place, in a certain direction in the heavens, and within a certain quarter-hour.

The peculiar movements hitherto observed of the clouds in question lead to the suggestion that perhaps a period consisting of several days exists, within which one and the same group of clouds is visible at the same hour from the same place, other conditions of the heavens being favourable. Every communication as to these phenomena will be valuable in the decision of this important point, which it has hitherto been impossible to settle, owing to the uncertainty of the weather and the fewness of the observers.

Those co-operating in our branch of research who are in possession of astronomical, photographic, or other physical apparatus, will of course be able to give more exact details as to place, movement, and constitution of the luminous clouds.

Suggestions for these observations cannot be given so briefly and simply; but for the sake of full and complete agreement between different observers, especially as to the point of time selected for taking photographs and measurements, members of the Society of Friends of Astronomy and Cosmic Physics are invited to communicate with O. Jesse, Steglitz bei Berlin, Albrechtsstrasse 30. This course would also be advisable in the close optical examination of the clouds with regard to the peculiar changes in strength of light and the degree and kind of self-luminosity which they perhaps send out together with the reflected sunlight.

In the night from June 25–26 of this year the summer reappearance of the luminous clouds was observed very brightly from Berlin and the neighbourhood.

More detailed particulars on the whole subject of inquiry are contained in a small paper by W. Foerster, which has been sent to all the members of the Society of Friends of Astronomy and Cosmic Physics.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

OXFORD.—Mr. G. C. Inge, Magdalen College, has been appointed to the Studentship offered to the University by the Managing Committee of the British School of Athens, from the Newton Testimonial Fund.

The death is announced of Dr. Evan Evans, Master of Pembroke College, who filled the office of Vice-Chancellor of the University from 1878–82.

Convocation has granted £25 towards the cost of the antiquarian researches at Chester, which are throwing great light upon the obscure period of the military occupation of Britain in the time of Agricola. Prof. Mommsen has appreciated the value of these researches.

At a meeting of the Junior Scientific Club, Mr. A. Colefax, Christ Church, read a paper on the investigation of the change taking place in acidified solutions of sodium thiosulphate. The subject of hypnotism was treated by Mr. E. L. Collis, of Keble; and P. C. Mitchell had an exhibit, and offered some remarks concerning primitive man in the Torquay caves.

The University has published the official Calendar for 1892. The arrangement and information contained differ little from former years. We learn that the number of undergraduate members of the University has increased from 3110 to 3212. The number of matriculations in 1890 were 771, as compared with 787 in the preceding year. The number of B.A. and M.A. degrees is very nearly the same as in 1889.

## *SCIENTIFIC SERIALS.*

*American Journal of Science*, November 1891.—The solution of vulcanized india-rubber, by Carl Barus. Experiments have been made by the author on the solubility of india-rubber in different solvents at different temperatures. Elastic sheet india-rubber, such as is used for rubber bands and tubing, is not fully soluble in $CS_2$ at 100° or 160°, but is quite soluble at 185°, and extremely soluble at 210°. It is also easily dissolved by liquids of the paraffin series at 200°. Various other substances have been used as solvents, and many remarkable results obtained. The importance of the paper may be gathered from the fact that in it is described "a method by which vulcanized india-rubber of any quality or character whatever, as well as the undecomposed or reclaimable part of rubber-waste, may be dissolved or liquefied in a reasonably short time, the solutions possessing any desirable degree of viscosity or diluteness, from which india-rubber may be regained on evaporation of the solvents."—Report of the examination by means of the microscope of specimens of infusorial earths of the Pacific coast of the United States, by Dr. Arthur M. Edwards. Seven new fluviatile fossiliferous deposits from Oregon, California, and Washington are described.—The Tonganoxie meteorite, by E. H. S. Bailey. An analysis of the meteorite gave the percentage composition: Fe 91·18, Ni 7·93, Co 0·39, P 0·10, and a trace of copper. The weight is 23¾ lbs., specific gravity 7·45, shape an irregular triangular pyramid 9½ inches long by 6½ inches wide by 4½ inches deep. A fine figure showing numerous pittings on the surface of the meteorite accompanies the paper.—Proposed form of mercurial barometer, by W. J. Waggener.—Colour photography by Lippmann's process, by Charles B. Thwing. The results obtained seem to indicate—(1) that mixed colours may be reproduced with a fair degree of accuracy; (2) that an exposure sufficiently long to give a clear image of the red is quite certain to obliterate the blue by over-exposure; and (3) that an over-exposure may completely reverse the colours, causing the original colours to appear on the reverse, and the complementary colours on the film side of the plate.—New analyses of uraninite, by W. F. Hillebrand. From the analyses it appears that the species may be broadly divided into two groups, one characterized by the presence of rare earths and the almost invariable presence of nitrogen, the other containing little or no nitrogen and no rare earths. Varieties of the former group occur in more or less well defined crystals, whilst members of the latter group are usually devoid of crystalline form.—The Tertiary silicified woods of Eastern Arkansas, by R. Ellsworth Call. The investigation has led to the following conclusions:—(1) The silicified woods of Eastern Arkansas are all of Tertiary age. (2) They are derived from the beds of Eocene clays that underlie the sands and gravels in which they commonly occur. (3) They are silicified lignite; the process of silicification has occurred either while they were still in clays, or most often after they were removed and buried in the sands or gravels. (4) They possess as yet no taxonomic value in determining the relative ages of the members of the Tertiary series.—Occurrence of sulphur, orpiment, axd realgar in the Yellowstone National Park, by Walter H. Weed and Louis V. Pirsson.—Mineralogical notes, by L. V. Pirsson. Some specimens of cerussite, hæmatite, and cassiterite, gypsum, and pennine are described.—Peridot dykes in the Portage sandstones, near Ithaca, N.Y., by J. F. Kemp.—A new locality of meteoric iron, with a preliminary notice of the discovery of diamonds in the iron, by A. E. Foote. The existence of black and white diamonds in the meteorite appears to be established by indifference to chemical agents and hardness. Carbon in the form of an iron carbide also occurs with the diamonds. The meteorite was found in Cañon Diablo, Arizona. Three figures accompany the paper.—The South Trap Range of the Keweenawan series, by M. E. Wadsworth.—Geological facts noted on Grand River, Labrador, by Austin Cary.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Mathematical Society**, November 12.—Prof. Greenhill, F.R.S., President, in the chair.—The President announced the recent decease of Mr. H. M. Jeffery, F.R.S., who was elected January 14, 1875.—The following gentlemen were elected to serve on the Council for the ensuing session: Prof. Greenhill, F.R.S., President; Dr. J. Larmor, Major P. A. MacMahon, F.R.S., and J. J. Walker, F.R.S., Vice-Presidents; A. B. Kempe, F.R.S., Treasurer; M. Jenkins and R. Tucker, Hon. Secs.; other members, Messrs. A. B. Basset, F.R.S., E. B. Elliott, F.R.,S. J. Hammond, C. Leudesdorf, A. E. H. Love, S. Roberts, F.R.S., Drs. A. R. Forsyth, F.R.S., J. W. L. Glaisher, F.R.S., and M. J. M. Hill.—The following communications were made:—On selective and metallic reflection, by A. B. Basset, F.R.S. It is well known that most transparent substances, which produce anomalous dispersion, exercise a strong selective absorption, and at the same time strongly reflect rays of the same periods as those which they absorb. Thus in fuchsine the order of the colours going up the spectrum is blue, indigo, violet; then there is an absorption band, followed by red, orange, yellow. The experimental laws relating to substances of this class may be summarized as follows: (1) the rays which are most strongly absorbed, when light is transmitted through the substance, are most strongly reflected; (2) when the incident light is plane polarized in any azimuth, the reflected light is elliptically polarized; (3) when sunlight is reflected, the colour of the reflected light, when viewed through a Nicol's prism whose principal section is parallel to the plane of incidence, is different from what it is when viewed by the naked eye. The phenomena of absorption, anomalous dispersion, and the like, have formed the subject of numerous theoretical investigations by German mathematicians. It is not the object of the present paper to propose any new theory upon the subject, but to discuss and extend the theory of von Helmholtz. The theory of von Helmholtz is an elastic-solid theory, which is based upon certain assumptions respecting the mutual reaction of ether and matter. The potential energy of the system may be conceived to consist of three distinct portions, viz. $W_1$, $W_2$, $W_3$, of which $W_1$ is the ordinary expression for the potential energy of an isotropic elastic solid; $W_2$ is a homogeneous quadratic function of the displacements of the matter; and $W_3$ is a similar function of the relative displacements of ether and matter, and is supposed to arise from the mutual reaction of ether and matter. Having obtained the expression for the energy of the system, the equations of motion can be at once written down; and it will be found, on integrating them, that the index of refraction, $\mu$, of light of period $\tau$, is given by the equation—

$$\mu^2 = \frac{\rho}{\rho_0} - \frac{\alpha^2\tau^2}{4\pi^2\rho_0}\left\{1 + \frac{\alpha^2 k^2\tau^2}{4\pi^2\rho_1(k^2 - \tau^2) - \alpha^2 k^2\tau^2}\right\} \quad . \quad . \ (1)$$

In this equation $\rho$ is the density of the ether when loaded with matter, $\rho_0$ is the density of the ether *in vacuo*, and $\rho_1$ is the density of the matter; $k$ is the free period of the matter vibrations, and $\alpha$ is a constant depending on the mutual reaction of ether and matter. If we suppose that the value $\tau_1$ of $\tau$, which makes the denominator vanish, corresponds to the double sodium line D of the spectrum, whilst a value $\tau_2$, which makes $\mu = 0$, corresponds to the hydrogen line F, $\mu^2$ will be negative when $\tau$ lies between D and F, and (1) accordingly represents a transparent medium (such as fuchsine) which has a single absorption band in that portion of the spectrum. Moreover, the dispersion is anomalous, since the value of $\mu$ when $\tau$ is a little greater than $\tau_1$, is much greater than its value when $\tau$ is a little less than $\tau_2$. To explain selective reflection, I have provisionally adopted Sir W. Thomson's hypothesis, that the ether is to be treated as an elastic medium, whose resistance to compression is a negative quantity, whose numerical value is slightly less than $\frac{4}{3}$rds of its rigidity. Under these circumstances, the amplitudes of the reflected light will be given by Fresnel's sine and tangent formulæ, according as the incident light is polarized in or perpendicularly to the plane of incidence. When $\mu^2$ is a negative quantity, these formulæ become complex quantities of the form $\epsilon^{-2\iota\pi f/\lambda}$ and $\epsilon^{2\iota\pi f_1/\lambda}$, and this indicates that reflection is total, and is accompanied by a change of phase; moreover, since the changes of phase, $f$, $f_1$, are different, according as the incident light is polarized in or perpendicularly to the plane of incidence, it follows that if the former is polarized in any azimuth the reflected light will be elliptically polarized. From these results it appears that the colour of the reflected light is of a greenish yellow when viewed by the naked eye; but when it is viewed through a Nicol, whose principal section lies in the plane of incidence, a considerable portion of the yellow rays are refused transmission by the Nicol, and the light under these circumstances is of a much richer green. Cauchy's formulæ for metallic reflection may be obtained from Fresnel's sine and tangent formulæ, by assuming that $\mu$ ($= \sin i / \sin r$) is a complex quantity of the form $R\epsilon^{\iota\alpha}$; but the experiments of Jamin, and the calculations of Eisenlohr, show that the real part of $\mu^2$ must be *negative*, which requires that $\alpha$ should lie between 45° and 90°. In fact, for silver, Eisenlohr finds that $\alpha = 83°$. Lord Rayleigh, on the other hand, has shown that, if we attempt to explain metallic reflection by introducing a viscous term into the ordinary equations of motion of an elastic solid, physical considerations require that the real part of $\mu^2$ should be *positive*; he has also shown that a similar objection lies against attempting to explain metallic reflection on the electro-magnetic theory, by taking into account the conductivity. If, however, we start with von Helmholtz's theory, and introduce a viscous term into the *equations of motion of the matter*, it will be found possible for the real part of $\mu^2$ to be negative, provided the free period of the matter vibrations lies between certain limits. We are thus able to construct a mechanical model of a medium which represents the action of metals upon ethereal waves, and which leads to the same formulæ for the amplitudes of the reflected waves as those given by Cauchy.—The contacts of systems of circles, by A. Larmor.—On a class of automorphic functions, by Prof. W. Burnside.—Note on the identity $4(x^p - 1)/(x \quad 1) = Y^2 \pm pZ^2$, by Prof. G. B. Mathews.—On the classification of binodal quartic curves, by H. M. Jeffery, F.R.S.—Researches in the calculus of variations; discriminating conditions in isoperimetrical problems, by E. P. Culverwell.—Note on Clifford's paper "On syzygetic relations among the powers of linear quantics," by Prof. Cayley, F.R.S.—Note on finding the G points of a given circle with respect to a given triangle of reference, by J. Griffiths.

**Linnean Society**, November 19.—Prof. Stewart, President, in the chair.—Mr. S. Jennings exhibited a collection of wild flowers made by him during a recent tour through the Rocky Mountains, California, and Mexico.—Prof. G. B. Howes exhibited some dissections of fish crania made by his pupil Mr. R. H. Burne, in which the parts of the skeleton were so displayed that they might be studied in relation to the rest of the head and to the leading cranial nerves.—Mr. E. F. Cooper exhibited specimens of a new variety of *Potamogeton* from Loughborough, lately described and figured by Mr. Alfred Fryer (*Journ. Bot.*, October 1891).—Mr. A. W. Bennett exhibited and made remarks upon some specimens of *Hydrodictyon utriculatum*, Roth. (*H. reticulatum*, De Toni), and some drawings of anomalous *Cypripedium* and *Disa*.—Mr. W. Carruthers, F.R.S., gave a graphic account of a recent visit to Sweden in search of original portraits of Linnæus, and detailed the results of his inquiries. His remarks were illustrated by an exhibition of engravings and photographs.—A paper was then read by Mr. Thomas Hick, on a new fossil plant from the Lower Coal-measures. An interesting discussion followed, in which Mr. Carruthers, Mr. G. Murray, Prof. F. O. Bower, Prof. Marshall Ward, and others took part.

PARIS.

**Academy of Sciences**, November 23.—M. Duchartre in the chair.—On some manuscripts with figures of historical interest relating to artillery and mechanical arts towards the end of the Middle Ages, by M. Berthelot. Some manuscripts from libraries at Munich, Venice, and Paris have been examined, and appear to be of interest as marking a stage in the development of applied sciences. A few of the mediæval figures are reproduced: one represents a diver in his costume; two others show primitive cannon, and one a small-arm used in the fifteenth century.—Preparation and properties of the phosphides of boron, by M. Henri Moissan. By the use of boron phosphoiodide, two boron phosphides may be obtained. The compound PB combines with $HNO_3,H_2O$ with incandescence, and inflames in an atmosphere of chlorine in the cold. The compound $P_3B_5$ is much more stable, and is not acted upon in the cold by these two reagents.—On some variations of the glycolytic power of the blood, and on a new method of experimental production of diabetes, MM. R. Lépine and Barral.—M. A. Potier was elected a member of the Academy in the place of the late M. Edmond Becquerel.—*Résumé* of a verbal report on a note by Prince Tourquistanoff, entitled "Le Calendrier vérificateur," by M. Wolf.—*Résumé* of a verbal report on a note by M. de Cohorne, entitled "Le Régleur solaire," by M. Wolf.—Observations of the total eclipse of the moon of November 15, made at Bordeaux Observatory, by M. G. Rayet.—Remarks *à propos* of the observation of M. Rayet as to the possibility of photographing the moon during a total eclipse, by M. A. Gautier.—Remarks on M. Rayet's communication, by M. J. Janssen.—Researches on the motions of stars in the line of sight made with the Paris Observatory siderostat, by M. Deslandres. (For the last four communications, see Our Astronomical Column.)—Remark on a communication by M. Markoff relative to linear differential equations, by M. Painlevé.—On the flow of liquids in capillary tubes, by M. Albert Colson. The influence of temperature on the rate of flow of viscous liquids is seen from the following comparison of the times in which 5 c.c. of glycerine passed through the tube:—

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|---|---|---|---|---|---|
| Temperatures ... | 21° ... | 100° ... | 150° ... | 250° ... | 265° |
| Duration of flow ... | 8h. ... | 360s. ... | 114s. ... | 40·5s. ... | 33s. |

The same tube passed 5 c.c. of water at 20° in 34 seconds. The author divides the liquids he has experimented upon into two classes, distinguished by being perfectly and imperfectly mobile. Ethers and aldehydes are representatives of the former class, for they appear to obey Graham's law that the duration of flow, or rather the rate of diffusion, is inversely proportional to the square root of the density. The values found for $\frac{t}{\sqrt{D}}$ in this class of liquids is practically constant. On the other hand, the liquids *imparfaitement mobiles*, such as alcohols and benzines, furnish irregular values.—Mechanical determination of the position of the atoms of hydrogen in organic compounds, by M. G. Hinrichs.—Aniline black in dyeing by the dry method, by M. A. Gautier.—On a codeïne violet, by M. P. Cazeneuve.—On the distribution of saccharine matters in the different parts of the edible *Cèpe* (*Boletus edulis*, Bull.), by M. Em. Bourquelot.—On the existence of veins of leucite in a Mont Dore basalt, by M. A. Lacroix. Leucite has not before been recognized in any of the volcanic rocks of the central plateau of France. The author fully describes the petrological characters of the specimens he has discovered, and also their peculiar mode of occurrence.—Earthquakes, submarine eruption, and elevation of land at Pantellaria, by M. A. Riccò. Earthquake shocks were felt at Pantellaria on October 14. On October 18, the sea to the west-north-west of the island, at a distance of about 5 kilometres, was seen in violent commotion, and a band of land about 1 kilometre long appeared, from which were ejected masses of heated rock and vapour. On approaching the place of eruption, a large number of dead fishes were found, and it was seen that the band was composed of an immense number of black floating masses of rock colliding together with great noise, and vaporizing the water over which they passed. On October 23 the position of the erupted island was determined as lat. 36° 50′ N., long. from Paris 9° 33′ E. The island was then about 200 metres long by 50 metres wide. The interior of some of the masses of rock was still hot enough to melt zinc.

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