THURSDAY, JUNE 30, 1887.

FORESTRY.

School of Forestry in Germany, with Addenda relating to a desiderated British National School of Forestry. By John Croumbie Brown, LL.D. (Edinburgh: Oliver and Boyd; London: Simpkin, Marshall, and Co., 1887.)

"SILVER and gold have I not; but what I have I am prepared to give." This is what the author tells us towards the end of the present volume, and there can be no doubt that he has fully acted up to his promise. He has now presented the public with what appears to be the fifteenth volume on subjects of forestry, and he offers to publish some thirty additional volumes if the necessary inducement is held out. Surely Dr. Brown must be extremely philanthropic, or else the publishing of books is considerably cheaper than we have so far believed it to be. These works, published and unpublished, deal with forest subjects in almost every known country of the earth, and we wonder how Dr. Brown has managed to collect all the information. The above-mentioned offer seems to have been made in succession to a variety of bodies, but none of them have availed themselves of it, and the world at large must, for the present, be satisfied with the information contained in the fifteen volumes which have so far passed through the press. That, however, extends over a considerable range, including information regarding forests and schools of forestry in Germany, France, Spain, Norway, Russia, and the Cape; on modern forest economy; the effects of forests on humidity of climate; hydrology of South Africa, &c., &c. Now, it appears to us either that Dr. Brown's works are deficient in interest, or that his countrymen are very ungrateful in not availing themselves of his handsome offer. If we follow the dictates of common-sense, we must, it seems, decide in favour of the former alternative.

We hear occasionally of a Parliamentary Committee which considers "whether, by the establishment of a forest school, or otherwise, our woodlands could be rendered more remunerative"; or a feeble effort is made to start a National British Forest School in Edinburgh; or a languishing controversy turns up, whether the junior officers of the Indian Forest Department should be educated in France, Germany, or at home. But on the whole these matters do not excite much curiosity or interest. Parliamentary Committees on the subject die away without making any proposals beyond suggesting the re-appointment of a similar Committee in the next Parliament, which event may come to pass if members have no bigger game to hunt; Edinburgh is still without its forest school, and a forestry branch has actually been added to the Royal Indian Engineering College at Cooper's Hill, for the education of Indian forest officers, without many people being aware of the fact. The explanation of all this indifference is that even the perseverance of Dr. Brown has not yet succeeded in convincing Englishmen of the importance of afforestation. The mere fact that it is of importance in various Continental countries and in several British dependencies is not sufficient to show that the same holds good in these islands, and it will be as well to say something more on this subject.

Forests are, in the economy of Nature and of man, of direct and indirect value: the former through their products, and the latter through their influence upon climate, the regulation of the water-supply, the healthiness of a country, and allied phenomena. These islands are rich in iron ore, coal, and peat, wherewith to produce more iron than is required by the country, and to render the question of firewood of very subordinate importance. What is more, they are so situated that the importation of wood and other forest-produce is comparatively easy and cheap, owing to their sea-bound position, and a multitude of railways and other means of communication scattered over the country. At any rate, we have received, so far, as much timber as we require, and at a lower rate than it has been possible to produce it at home. Whether this state of things will last for ever is a different question; but it rests with us to initiate measures in our dependencies (such as Canada) which will secure us against a timber famine as long as the British Navy rules the sea. After all, the whole question turns on this point, and the decline of the British Navy would raise other issues of such immense importance, that the question of the future timber-supply of this country may well be added without producing a nightmare in even the most imaginative mind.

Again, in respect of the indirect effects of forests, Englishmen may rest assured that the absence of woodlands will not ruin their country. The climate and rainfall of these islands are principally governed by their geographical position. Strong moist air-currents come to us direct from the sea, and, compared with their effects, those of forests, even if 20 per cent. of the total area of the United Kingdom were covered with them, would be found comparatively small. Nor need we cry for forests on account of the general regulation of moisture; because, thanks to an ample rainfall and a comparatively moist state of the atmosphere, our waste lands are generally covered with heath, mosses, and other growth, which act as powerful retainers of moisture. To add a crop of trees to these would make comparatively little difference, especially as afforestation would, in many cases, have to be accompanied by the draining of the soil.

In some respects, however, an increase of our woodlands might be highly beneficial. They would afford protection not only to cattle and birds (the latter being the great destroyers of noxious insects), but also to agricultural lands which are at present exposed to strong sea breezes. A judicious distribution of woodlands along the coasts (especially the western) of these islands would no doubt be followed by beneficial results in this respect. Again, our waste lands (occupying upwards of 40,000 square miles, equal to 34 per cent of the total area), might be made more remunerative than they are at present, and their afforestation would provide a very considerable amount of work, not only by the creation and subsequent management and working of the forests, but also by the springing up of a variety of industries dependent on the existence and sustained yield of woodlands. We take this opportunity to recommend the subject to the careful attention of those who are about to legislate once more on the Irish land question. Experience has shown that the climate of a considerable portion of Ireland (especially in the coast districts) is not sufficiently favourable to produce crops which will permanently support the cultivator and yield large rents to the owners of the soil. In such cases the afforestation of surplus lands (that is to say, lands not required for agricultural operations) might prove a useful auxiliary in the solution of the Irish land question, by providing additional work which would enable the small cultivator to earn a day's wages whenever his presence was not required on his holding. Instead of sitting idle during a good portion of the winter, he could appreciably augment his income (and capacity to pay rent), without being obliged to leave his home in search of distant work

However, we must return to Dr. Brown. Our author has in the book under notice placed before the few who may be interested in the question, a fair account of how forest schools are arranged in Germany, the country where forest science has attained its highest development. The arrangement of studies at the several schools is given in considerable detail, and the book shows the high standard of education of German forest officers. Some of the schools are independent institutions situated in or near extensive forests, while others form part of Universities or technical Colleges. In the former case the education takes generally a more practical turn, while under the latter arrangement a higher standard of general education is likely to be secured. Dr. Brown is in favour of attaching the desired British forest school to a University or other similar educational establishment. In our opinion the decision on this point should depend on the class of men whom it is desired to educate. The ordinary foresters required by British landowners for the management of their woodlands are men who could not be enrolled as members of a University College; and their education must be of a more simple description, with a strong practical tendency. But men who are to join the general administration of India should attain a high standard of education, and a forest school for their benefit might well be attached to a University or to a high-class College. Unless such men are fit to take their proper place amongst the rest of the governing staff of the country, they will not be able to do justice to the work which will be intrusted to them on their arrival in India.

Both wants cannot be met by one set of men. The employment of men who have merely had a practical training might be disastrous to the Indian forests. On the other hand, British landowners would decline to receive men who, in consequence of a College education, would be above the ordinary work of a British forester, not to mention the fact that such men would expect higher rates of pay than the owners of woodlands would be willing to give them. In short, the course of studies to be followed by each of these two classes of men must be arranged on different lines. In either case, however, a tract of well-managed woodlands should be situated close to the seat of the school. To do without such a training-ground would be equivalent to training medical men without a hospital ready at hand. On this point we are decidedly at issue with Dr. Brown, who, in declaring such a school-forest unnecessary, has, in our opinion, only proved that he has failed to grasp the essential requirements of a forester's training. At the same time, the reader of Dr. Brown's books cannot help wondering at the marvellous industry employed by the venerable author in the compilation of his various works on Continental forest schools. Such energy and devotion are deserving of a better reward than they are likely to meet with, owing to the apathy on forest questions existing in this country. SW.

OBSERVATIONS AT GODTHAAB.

Observations Internationales Polaires, 1882–83. "Expédition Danoise: Observations faites a Godthaab sous la direction de Adam Paulsen." (Copenhague, 1886.)

THIS part of the publications of the Meteorological Institute of Denmark deals with the meteorological, tidal, and other observations made in 1882–83 by the Danish Arctic Expedition at Godthaab (64° 11′ N. lat.; 51° 44′ W. long.). The pages devoted to meteorology present us with detailed tabular views of the hourly observations of atmospheric pressure, temperature, and humidity, and the direction and velocity of the wind These are prefaced by an interesting and full discussion of the atmospheric pressure (illustrated with 186 pressure and wind charts of Greenland), which includes a valuable comparison of the observations of that year with those at all the stations since 1866.

In summer the mean lowest temperature, 38°·2, occurs at 2 a.m. and the highest, 43°·1, at 2 p.m., the daily range being thus 4°·9. On the other hand, the mean daily range of temperature is extremely small in winter, owing to the proximity of Godthaab to the Arctic circle. Thus the highest and lowest hourly temperatures were respectively in December, 19°·5 at 10 a.m. and 18°·0 at 10 p.m.; in January, 15°·1 at 5 p.m. and 14°·1 at 1 a.m.: and in February 4°·4 at 6 p.m. and 3°·7 at 3 p.m. Thus in February the mean warmest and coldest hour of the day show a difference of only 0°·7, and are only three hours apart from each other. Quite different is the amount of the daily range of temperature deduced from the maxima and minima of the month; in February the mean of all the highest was 9°·0 and of the lowest 0°·3, the difference being 8°·7. In these months the changes of temperature are but little influenced by the sun, being almost altogether occasioned by the passage of the cyclones and anticyclones. It is this practical elimination of the influence of the sun which gives a peculiar value to the temperature and hygrometric observations of such stations when any serious attempt is made to assign to these important elements the parts they play in the history of storms. The mean annual temperature calculated from the twenty-four hourly observations is only about one-tenth of a degree lower than that from the daily maxima and minima. In all the months the agreement is close, the greatest difference being 0°·5 in February and August; and in seven of the months the difference did not exceed 0°·1.

The results giving the variations in the hourly velocity of the wind are interesting as showing that such diurnal variation as may exist will require a number of years' observations to show it clearly, this periodicity being masked in an unusual degree by the high winds which accompany the low-pressure systems of Greenland.

With eighteen years' observations (1866–83) at Ivigtut, Godthaab, and Jacobshavn, and nine years' (1875–83) at Upernivik, we can now present, with an approximate correctness not hitherto attainable, the distribution of pressure over Greenland during the months of the year. The following mean pressures, at 32° and sea-level, give the highest and lowest, with the months of their occurrence:—

	Highest. Inches.	Lowest. Inches.	Year. Inches.
Ivigtut	29·827 in May.	29·398 in January.	29·666
Godthaab ...	·847 ,,	·445 ,,	·684
Jacobshavn..	·898 ,,	·565 ,,	·749
Upernivik...	·981 in April.	·603 ,,	·753

Thus in Greenland pressure increases with latitude. The difference between the extreme south and north is in January 0·205 inch, and in spring 0·154 inch; but the difference in summer is small, being in July only 0·008 inch. The above mean of January at Ivigtut 29·398 inches, and for the same month at Stykkisholm in the north-west of Iceland 29·396 inches, are, so far as known, the lowest mean monthly pressures anywhere yet observed in the northern hemisphere; and it is interesting to note that it is in the region immediately to the south and south-west of these places that a very large number of our European storms have their origin.

Attention is forcibly drawn by the 186 charts of pressure and wind to the remarkable fact that the depression areas of Greenland appear to travel from north to south. An extension of the area charted would doubtless show that while in many cases these areas travel northwards yet in a considerable number of cases this direction is more apparent than real. It is, however, abundantly evident that Greenland exerts an important influence on our Atlantic storms that remains still to be investigated.

The most elaborate part of the paper is the discussion of the diurnal curves of pressure from the hourly observations. The curve for the year exhibits the two usual maxima at 8 a.m. and 8 p.m., and the two minima at 2 a.m. and 1 p.m., the morning minimum and the evening maximum being respectively the greater, and these features of the curves are, with one exception, reproduced in the curves for the months. The results will be made to tell their story more clearly if we eliminate the more prominent irregularities attaching to means of one year only, by bloxaming the hourly means, by taking for the hourly means of each month means calculated from that month, the month immediately preceding, and that immediately following it. In these new mean hourly values the morning greatly exceeds the evening maximum in February, March, and April, whereas in every other month the reverse holds good, and that in a very pronounced degree. On the other hand, the morning greatly exceeds the afternoon minimum in each month of the year. From the relations the results show to those for places in similar situations in lower latitudes, we may conclude that unusual care has been taken in securing for the barometer a position where it was subject to only a very small daily change of temperature. It is absolutely necessary that this condition should be attended to, if observations are to be of any use at all in the discussion of the important question of the horary variations of pressure in high latitudes. Since the variations dealt with seldom exceed 0·010 inch, and are generally much less, it is evident that the inquiry is for these regions a refined one; hence it is essential that the attached thermometer should represent the temperature of the whole instrument to within 1° F. It is the neglect of this point that vitiates several series of horary barometric observations in the Arctic regions.

Over the open sea in high latitudes during the summer months, where the sun either does not set, or only for a brief interval, the diurnal curve of pressure differs essentially from the above. The observations made by the *Challenger* Expedition in the Antarctic Ocean, and those made by the Norwegian Expedition in the north of the Atlantic, show only one maximum and one minimum in the day, the maximum occurring during the day and the minimum during the night. This peculiar curve is restricted to the open sea of high latitudes. Director Paulsen is inclined to the opinion that the diurnal variation of pressure at Godthaab is caused not so much by local variations of temperature and humidity as by transmissions from lower latitudes of their diurnal variations of pressure. In this opinion we to some extent concur, it being probable that some of the more prominent features of these daily curves of pressure are the results of vast quasi-tidal movements communicated through the higher regions of the atmosphere, in which the space traversed by the individual aërial molecules is not necessarily great.

OUR BOOK SHELF.

Essays and Addresses. By the Rev. James M. Wilson, M.A. (London: Macmillan and Co., 1887.)

In these "Essays and Addresses" Mr. Wilson deals chiefly with problems connected with religion and morality, and his main object seems to be to show that theological and ethical principles, properly interpreted, are supported, instead of being contradicted, by scientific ideas. The book is evidently the result of much independent reflection. Mr. Wilson tries to grapple with no intellectual difficulty which he has not thoroughly examined, and in all his statements of scientific doctrine he is scrupulously exact. He refers to science in so many aspects that much of what he has to say may be studied with interest even by readers who do not feel that his arguments with regard to such subjects as "Miracles" and "Christian Evidences" are perfectly conclusive.

Introductory Text-book of Physical Geography. By the late David Page, LL.D., F.G.S. Twelfth Edition. (Edinburgh and London: W. Blackwood and Sons, 1887.)

This book was originally published about twenty-five years ago, and has done good service in many schools and colleges. After the author's death it was brought up to date by Dr. Charles Lapworth, who, besides making a number of minor corrections and additions, contributed a summary of those results of the *Challenger* Expedition which had reference to the depths, deposits, and temperature of the ocean; an account of British storms; a description of the biological regions of the earth; and a short sketch of Prof. Huxley's arrangement of the human family. In the present edition Dr. Lapworth has again sought to bring the work abreast of scientific knowledge, introducing new matter relating to geology and petrography, meteorology and climatology, and the distribution of animals and plants. On the latter subject he has obtained from Prof. D'Arcy Thompson an excellent summary of recent biological research and theory. The value of the book has also been increased by the insertion of several new maps illustrative of the astronomical and meteorological sections.

Longman's New Geographical Reader. Standard VII. (London: Longmans, Green, and Co., 1887.)

THIS "Reader" contains lessons on the ocean, currents, tides, the planetary system, and phases of the moon. The subjects are of more scientific interest than those treated in most books on geography, and are arranged in a progressive and readable form.

The book is divided into sixty lessons, each being followed by a list of some of the words contained in it, with their meanings.

In the chapters on the ocean the subjects are well selected, and the various depths and currents are illustrated by maps. In the lesson on the tides the differential action of the sun and moon on the water of the earth should have been mentioned. The diagram illustrating neap tides has one bad point, the sun being shown as shining on a part of the moon which is turned away from it.

In the diagram on page 231, which represents the sun as seen in full daylight from the surface of the moon, the sun is shown with its corona. The fact of the sun being seen from the moon, which has no atmosphere, would not make the corona visible, but would only tend to intensify the light of the sun and the corona proportionally. It is a pity that this illustration should have been put in without any explanation whatever.

The chapters on the inhabitants of the sea and methods of catching them are very interesting; also the voyages to the Arctic and Antarctic regions. An appendix is added which contains a summary of the whole book.

LETTERS TO THE EDITOR.

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

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

The New Degrees at Cambridge.

THE letter of "Outis" in yesterday's number of NATURE (p. 175) is likely, I fear, to convey a false impression as to the new degrees of Doctor of Science and Doctor of Letters, which, by the way, were instituted, for good or for evil, by the Commissioners, and not by any "dominant body in the University." It is true that Doctors in the new faculty take precedence after Doctors in Medicine just as Doctors in Medicine take precedence after Doctors in Law, and Doctors in Law after Doctors in Divinity, but this distinction is only of importance when a procession has to be marshalled; to all intents and purposes the academic rank of all Doctors is the same.

If it be true, as I believe it is, that the standard for admission to the regular degree of Doctor in Science is only "rather less than that required for admission to the Royal Society," and that the standard for Doctor in Letters is much the same, it follows that the standard for such degrees is much higher than that for any other Doctorate in the University, while that for Doctor in Law is notoriously the lowest of all.

Since the new degrees were instituted the Council has usually offered the new degrees to those persons selected as recipients of honorary degrees whose claims were essentially scientific or literary, while it has continued to give the honorary LL.D. to persons whose distinction was of a less academic kind. This may have been wise or unwise, but the Council had certainly no idea that in what they were doing they were offering to men of science an honour of a lower grade than that to which they had been accustomed. It is true that, fearing perhaps that the less familiar title might at first be not so well understood outside the University, they began by offering to the recipients the choice of the degree of LL.D. or of Litt.D. or Sc.D., as the case might be; but I believe that in all cases those who had the choice preferred the literary or scientific degree.

No doubt these degrees, like that of LL.D., have been and will continue to be given to men of very different degrees of eminence. It is not every year that the University has the opportunity of enrolling among its honorary graduates a man like Asa Gray; but I think that, even if he is excluded, the roll of our honorary Doctors in Science and Letters need not fear comparison with that of the honorary Doctors in Law who have received their degrees within the same period.

Cambridge, June 24. C. T.

Weight, Mass, and Force.

THE position taken up by "P.G.T." and some others in the discussion on the proper use of the words "weight" and "mass" is similar to that assumed by an astronomer coming forward to tell us that we have been calling the stars by their wrong names.

The following extract from an American technical journal is submitted to the consideration of "P. G. T.," Mr. Hayward, and Mr. Alfred Lodge, in order that they should point out for our benefit where they consider the dynamical language is erroneous, and that they should translate it into the terminology necessary in their opinion to make it correct by using the mathematical terminology of poundals, dynes, moms, poundems, &c.

"DESCRIPTION OF THE STRONG LOCOMOTIVE."

American Journal of Railway Appliances, March 15, 1887.

"The weight of the engine in working order is 137,000 lbs., of which 90,000 are on the drivers, 27,000 on the front truck, 20,000 on the back truck. The weight of the tender loaded is 75,000 lbs. The boiler carries 160 lbs. of steam, which pressure is easily maintained when the engine is pulling the heaviest and fastest trains over the 96-feet grades across the mountains.

"The engine having 20-inch by 24-inch cylinders, and 62-inch drivers, the traction force is, according to the well-known formula, $20^2 \times 24 \div 62 = 154{\cdot}8$ lbs. for each lb. of mean effective pressure in the pistons. The resistance of modern rolling-stock as deduced from the most recent experiments both in this country and in Europe is from 12 lbs. per ton of train including engine and tender at speeds of 30 miles an hour to 15 lbs. at 50 miles an hour, above which point the resistance increases in a much greater ratio.

"Let us suppose then that the engine is hauling a train at 30 miles an hour on the level, cutting off at 10 inches of the stroke. From indicator cards taken from the engine under these conditions we find that a mean effective pressure of 100 lbs. is maintained in the cylinders. The traction force exerted will thus be $154{\cdot}8 \times 100 = 15480$ lbs.; and taking the resistance at 12 lbs. per ton, we find the maximum load the engine can pull is $15480 \div 12 = 1290$ tons, and subtracting from this the weight of the engine and tender there remains a weight for the train $1290 - 106 = 1184$ tons, or the equivalent of no less than 59 20-ton cars.

"Now suppose the engine is running up a grade of 96 feet to the mile (1 in 55) at the same speed and cutting off at the same point as before. The resistance to gravity on a 96-feet grade is $2240 \div 55 = 41$ lbs. per ton, and this added to the 12 lbs. resistance on the level gives $41 + 12 = 53$ lbs. per ton for the train going up the grade. Under these conditions the load hauled would be $15480 \div 53 = 292$ tons; or, subtracting the engine and tender, $292 - 106 = 186$ tons, the equivalent of $9\frac{1}{2}$ 20-ton cars.

"Turning now to the question of adhesion, we find that taking the coefficient of adhesion at one-fifth, we have a weight of 18000 lbs., one-fifth the weight on the drivers, as against the 15480 lbs. of traction. We need hardly say that the average coefficient of adhesion is usually higher, one-fourth being generally taken in calculations relating to the performance of locomotives. Under this condition the weight available for adhesion would be 22222 lbs., or one-fourth the weight on the drivers, and the mean effective pressure in the cylinders would have to amount to $22222 \div 154{\cdot}8 = 143{\cdot}6$ lbs. per square inch before the wheels would begin to slip or the use of sand become necessary. At the speed of 30 miles an hour and 100 M.E.P. (mean effective pressure) this engine would exert about 1240 H.P.," &c.

This account is written by someone to whom the dynamical problem is a reality and no theoretical abstraction: he employs throughout the gravitation measure of force, and to an engineer there is no ambiguity in his use of the words pound and ton sometimes in the sense of mass or weight and sometimes in the sense of force.

Prof. A. B. W. Kennedy, in his "Mechanics of Machinery," pp. vii. and 222, has called attention to the same ambiguity of language, and points out that the word pound is used in two senses (three senses when pound-sterling is to be distinguished), which he proposes to distinguish as weight-pound and force-pound; not, observe, mass-pound and weight-pound as the mathematician would have us call them.

An article in the current number of *Wiedemann's Annalen*, No. 6, 1887, by A. Oberbeck, "Ueber die Bezeichnung der absoluten Maass-systeme," shows that a similar controversy on dynamical terminology is now going on in Germany.

The mathematical definition that "the weight of a body is the force with which the earth attracts the body" must disappear and be replaced by "the attraction of the earth on a pound, a ton, or a kilogramme, is called the force of a pound, a ton, or a kilogramme;" these are gravitational units of force, derived originally from statical considerations, but used in practice for dynamical problems also; but inasmuch as the magnitude of these units depends on the local value of g, they are unsuitable for astronomical or electrical purposes, and are now replaced in such cases by the absolute units of force, the poundals, dynes, &c.

The defect of modern dynamical teaching is the unreality of its applications; it is too much the "dynamics of a particle." Were the student accustomed to examples taken from the magnificent problems presented by the latest industrial developments, he would become accustomed to the use of gravitational and absolute units of force, and recognize their respective advantages. A. G. GREENHILL.

Woolwich, May 30.

Upper Cloud Movements in the Equatorial Regions of the Atlantic.

RECENT communications to your paper have given the motion of the upper clouds from the eastward in the equatorial regions of the Atlantic. My observations (the result of having passed through these regions sixteen times in sailing-ships) give the motion of the upper clouds from the westward: and the motion of the intermediate cloud layers, consisting of the high low-level stratiform clouds (cirro-cumulus and such like), from a point somewhat to the north of east on the north side of the equator. Intermediate clouds are rare in the equatorial regions south of the Line. The high low-level clouds are constantly being confounded with the true high clouds.

There is another source of error in noting upper cloud movements; little attention has been paid to a movement of propagation. So marked is this at times, that they are propagated over the sky quicker than they are moving, this movement being frequently at right angles to the direction of motion.

DAVID WILSON-BARKER.

The Shadow of Adam's Peak.

THE shadow of Adam's Peak, to which Mr. Abbay refers in his letter to NATURE, vol. xxxvi. p. 152, is certainly not the kind of shadow that I witnessed, but that which is only seen in the clearest weather and without the intervention of mist. This is mentioned in one of the last paragraphs of my paper.

Nevertheless, I cannot think that mirage has anything to do with that shadow. When the Observatory was first established on Pike's Peak, the observers used to see the shadow of the mountain rising against the sky on the far distant horizon. At first they thought this very curious, but soon found that the appearance was always there in very fine weather.

Further observation showed conclusively that the appearance was simply the ordinary earth shadow of sunrise projected so clearly against the sky, that an irregularity such as a sharp peak could be distinguished on the edge of the generally circular shadow.

I do not think that mirage has anything to do with this anti-crepuscular shadow, but no doubt there are abundant thermometric observations in America for anyone who wishes to investigate the subject further. RALPH ABERCROMBY.

21 Chapel Street, London, June 17.

Temperature and Pressure.

I HAVE to thank Mr. S. A. Hill for replying to my letter, and it is most interesting to know that the same connexion between temperature and pressure exists in India as in Jamaica (NATURE, vol. xxxv. pp. 437, 606).

No doubt, as Mr. Hill observes, different localities will have different values of the coefficients λ and μ in the equation—

$$\delta T = \lambda \delta P + \mu (\delta P)^2;$$

indeed, we must expect very different values; but still, by putting $\delta P = 0$ in the equation for *minimum* temperatures, each locality should give the same limiting temperature, which we may regard as the temperature of space.

It is of course to such concordance that we must look for the determination of the temperature of space, so defined, rather than to extreme care in the taking of observations in any one particular part of the world.

With reference to Mr. Hill's remarks about extrapolation, it is hardly necessary for me to point out that astronomical refraction is caused by the whole terrestrial atmosphere, and that some law between temperature and pressure must be adopted before refraction-tables can be constructed; Mr. W. H. M. Christie, the Astronomer-Royal, has, in the Memoirs R.A.S., vol. xlv. p. 177, recently pointed out how errors may arise from this source.

Indeed, errors must arise from this source. In Jamaica the values of λ and μ are not the same for mean and minimum temperatures, or, roughly speaking, for day and night; neither is it to be expected that they will be the same anywhere else. But enough has been said to indicate the importance of the problem, and the steps which should be taken for its solution.

Jamaica, June 6. MAXWELL HALL.

British Association Sectional Procedure.

IN reference to Prof. Thompson's letter (June 16, p. 151), will you allow me to say that in 1884 I went from the meeting of the Association of American Microscopists at Rochester, N.Y., to that of the British Association at Montreal. At the former the proceedings commenced daily at 9 a.m., closing about noon, and another short session was held in the afternoon. The middle of the day was thus left at liberty for Committee work, sight-seeing, or rest, and the greater amount of work got through in the day as compared with the usual plan at our Association was very striking. ALFRED W. BENNETT.

6 Park Village East, Regent's Park, June 18.

Mirage.

THIS afternoon, shortly after 4.30 p.m., my attention was drawn to an extraordinary and wonderfully perfect "mirage." My house, situated almost on the extreme point of Hartlepool, near the Heugh Lighthouse, overlooks with a south aspect the Hartlepool or Tees Bay, Redcar, Saltburn, and in clear weather a beautiful high coast-line stretching from Saltburn to Staithes. When first seen, all the houses of Redcar, some seven miles distant, and lying almost at sea-level, were enormously elongated to at least six or seven times their ordinary height, and looked like high square towers with intensified colouring. I could not however determine (with the aid of an opera glass) whether the phenomenon was a simple elongation or whether the upper part of the "mirage" was an inverted image of the houses. I am inclined to think that the lower two-thirds was an elongation of the buildings, while the upper third was an inverted image.

During the height of the mirage a dark misty stratum of air, bounded by a distinct upper margin parallel with the horizon, and decreasing in density towards it, stretched from the western end of Redcar through an arc of almost 90° seawards. I estimated the height of this stratum at 35′ to 36′ of arc. After some 10 minutes the "mirage" gradually dwindled over Redcar, but remained distinctly visible for a short time longer over Saltburn, the coast-line, and out to sea. At Saltburn, about 11½ miles distant, some of the buildings were duplicated, a white house being visible as two spots widely separated. The normal coast-line south of Saltburn was obscured by the haze, but a beautifully clear "mirage" of it was visible, taking as its horizon the upper margin of the misty air stratum, the horizon being thus bodily raised through some 36′ of arc. Out at sea in an almost easterly direction a smoking steamer was faintly visible with an inverted image, masthead touching masthead, and a small schooner under sail, some 8 or 10 miles away, exhibited an inverted image of its topsails. In the direction of Saltburn a tug-boat (paddle steamer) steaming within perhaps 2 miles of the coast was quite normal in appearance. The smoke rising from it drifting eastward appeared normal for a short time, but suddenly expanded on rising to about ten times its thickness, and then tailed off again at its topmost eastward corner to the normal thickness. A large steamship lying about half-way across the bay showed no signs of being affected by the "mirage."

These phenomena disappeared in about 20 minutes, and were followed by a haze which obscured the distance.

The weather had been very hot and sultry all day, with about 70° in the shade, and a gentle south-east by east breeze, and a perfectly clear sky.

Estimating the height of the Redcar houses at 50 feet and the distance at 7 miles, they would occupy 5′ of arc; and taking the thickness of the air stratum producing the "mirage" at 35′ of arc, the elongation of the buildings would be seven times their ordinary height.

Though I have been informed that "mirages" were visible on the previous hot days, the phenomenon is on the whole of rare occurrence here, and has never been witnessed by myself before. CHAS. O. TRECHMANN.

Hartlepool, June 18.

P.S.—My point of view would be about 20 feet above sea-level.

A Suggestion for Anthropologists.

So far as the undersigned has seen, all reviewers of the "Précis d'Anthropologie," lately issued by Profs. Hovelacque and Hervé, of Paris, have noted with no little interest the attitude of the work towards the problem of the origin of man. Rejecting on the one hand the doctrine of the monogenesis of the human family in the way of a purely natural evolution out of lower forms of life, and on the other hand discrediting the polygenesis of men by special creation in different centres of distribution, these eminent anthropologists present, as the probable truth, a compromise hypothesis, which they call *transformisme polygénique*. According to this view, men were evolved from the lower animals, but in more than one original centre, and from more than one original pair. A French reviewer has well intimated the significance of this new teaching by observing that it marks a distinct schism in the ranks of the Darwinistic anthropologists, and inaugurates debates and investigations from which most important new light may be expected.

In this connexion it has occurred to me that if I were an anthropologist, and especially one of Darwinian principles, I should be exceedingly eager to institute investigations looking to the establishment or overthrow of a still different conception of the matter—one not yet studied with anything like the thoroughness which it deserves. I might call the hypothesis to which I allude the hypothesis of *transformisme bigénique*. Being neither its inventor nor a believer in it, I can the more freely call the attention of believers in transformism to its decided richness of promise. Indeed, if there is any middle ground of truth between the anthropology of Darwin and the anthropology of Agassiz, it can nowhere so hopefully be sought as precisely here. The hypothesis to which I refer is that according to which the human family consists of the descendants of two primitive human races—the one white and originating at the North Pole, the other dark and originating at the South Pole.

The only work in which I have ever found this view suggested is one published in Sweden about the year 1842, and two years later in an English translation, in London, under the following title: "The Theogony of the Hindus; with their Systems of Philosophy and Cosmogony. An Essay, by Count M. Björnstjerna." I may be allowed to add that all I have published respecting the north polar origin of the race was already in its third edition before I had seen, or had any knowledge of, this work.

For the further satisfaction of those readers to whom the work may not be easily accessible, it may be stated that the idea is by no means elaborated and formally presented as a scientific solution of the problem of the origin of man. On the contrary, it is so transient and incidental a suggestion on the part of the Count that the substance of all he says is found in two sentences on page 177 of the English translation, as follows:—"As, according to the nature of the thing [*i.e.* owing to the secular cooling of the earth], both the polar regions must have been prepared equally early for the reception of mankind, it is possible that the appearance of man took place at the same time in both regions; perhaps the white race in the countries about the North Pole, and the black race in those about the South Pole. A number of difficult problems might hence be solved." How singular it would be if this passing remark of a Swedish Count, writing upon the mythology of the Hindus, and more than a generation ago, should prove to be the watchword of the most advanced school of scientific anthropologists at the opening of the twentieth century. WILLIAM F. WARREN.

Bad Gastein, Austria, June 20.

Snow in Central Germany.

IN a note in NATURE of May 12, p. 42, it was stated that the quantity of snow which fell in Central Germany from December 19 to 23, between 50° and 52°·5 N. latitude, and between 7° and 18° E. longitude, weighed no less than 10,000,000 tons. I think there is a mistake in the calculation. Supposing that the snow was equivalent only to a stratum of water of 5 centimetres in height, its weight would be not 10,000,000, but 10,000,000,000 tons. OTTO KNOPF.

Berlin, June 21.

Meteor.

AT about 7.45 p.m. on June 19 a brilliant meteor was seen in broad daylight from this place. At a rough estimate it followed the meridian of Antares for about 30°, and disappeared near the meridian of that star. H. KING.

Chithurst, Petersfield.

Medicine in McGill University.

IN a criticism of my "Outlines of Lectures on Physiology" which appeared in NATURE for May 12, you say:—"Pathology, or the application of physiology to disease, is hardly touched upon in this book. It is a most unfortunate omission unless both pathology and therapeutics are taught more systematically than with us." About three years ago "Institutes of Medicine" (then including physiology proper, histology, and pathology) was divided, and now these departments are each taught separately, and each is provided with its own laboratory. A systematic course of lectures and demonstrations in pathology is given, with instruction and practice in making autopsies (after Virchow). Therapeutics is taught from the physiological point of view, and also has its own laboratory. So that it only becomes necessary to make such reference to pathology, &c., in the lectures on physiology as suffices to indicate that the subject does bear on the study of disease, and thus interest the student in it from its bearing on his life-work.

It may be interesting to English readers to learn that very recently two of Montreal's citizens have given one million dollars to erect and endow a "Royal Victoria Hospital" in commemoration of the Queen's Jubilee. This hospital is to be located close to McGill University.

I make these statements simply in justice to the Medical Faculty. T. WESLEY MILLS.

Physiological Laboratory, McGill University,
Montreal, May 28.

The University of Tokio.

IN vol. xxxv. of NATURE, p. 401, it was stated that the recent amalgamation of the Engineering College and the University of Tokio occasioned the "total elimination of Europeans from the teaching staff, their place being taken by Japanese." Justice to the new University requires the correction of this statement, which is not only misleading, but erroneous. It is true that two well-known foreign Professors vacated their posts—one immediately after the amalgamation, and the other within six months thereafter. Their place, however (for they taught the same subject), is soon to be filled by an engineer who is expected shortly from England. But giving full allowance to this temporary vacancy, any person who will take the trouble to compare the number of foreign Professors in the two establishments before the incorporation with the number after will find that "the total elimination" amounts to "one." Since the publication of the Calendar, again, no fewer than six have been added to the list of European Professors in the University. S. SEKIYA.

Imperial University, Tokio, April 22.

SCIENCE FOR ARTISTS.

ON many former occasions, furnished by the opening of the Royal Academy, the Grosvenor, and other exhibitions of pictures, we have made some remarks upon them from a specially scientific point of view, endeavouring in this way to note if any progress has been made in the treatment of natural phenomena by artists. This has also sometimes been accompanied by minute criticisms of certain pictures in which such phenomena have been admirably portrayed, or, on the other hand, travestied. Our remarks naturally have referred more to landscapes than to the other classes of pictures exhibited, first, because we have to deal chiefly with physical phenomena, and secondly, because, in representing the human form, artists have now for many years received such complete instruction that there is little chance of any gross error being committed. Why we think it worth while to write these articles at all is that, so far as we can find out, in no scheme of art instruction does the study of natural phenomena find any place, and one of our objects is to show that such instruction ought to be given to artists side by side with their anatomical work, in order to prevent them from making grotesque blunders which destroy all the artistic beauty of a picture, however well painted, in the eyes of the initiated. It happens very curiously that the various scientific points which are raised by the pictures exhibited vary from year to year. This alone would indicate the many points of contact between science and art, beyond those which we usually recognize. This year we think the questions raised by the pictures exhibited in the Royal Academy to which we now confine ourselves, for it really comes to that, are smaller in number than they have been for some time past, and are more restricted in scope. This arises, we believe, in a great measure from the very distinct improvement in the landscape pictures generally. The air has more atmosphere about it, the skies and clouds are truer in colour and form, the play of light upon water, the forms of waves, and many such points as these, to which reference might be made, have received better and more careful treatment. The most wonderful play of colour in Nature is brought before us at sunrise and sunset, and the only wonder is that artists do not pay more attention to the magnificent pictorial effects which are provided by these natural displays. This wonder, however, no doubt is greatly reduced when we come to consider the enormous difficulty of the problem. In the first place, there is no book, as far as we know, containing any statement in regard to sunset colours which will help an artist who wishes to paint them. Again, the play of colour in cloud and sky, in the objects illuminated by the fading and coloured light, varies incessantly; while, perhaps worst of all, the artist himself has to choose his colours from a palette which is illuminated by a light the colours of which are constantly changing as the sun gets lower and lower. In spite, however, of these enormous difficulties, artists have succeeded in producing sunset pictures of great beauty, nor are they absent in the present Academy Exhibition. No. 52, "Sunset after a Shower," is a case in point. Sunsets are not always so exactly alike as the painter of that picture paints them, as if pictures represented the different states of an etching, but the picture in question has many beauties about it, and, as all good pictures should do, it raises a question. In it we are supposed to be looking very nearly towards the place of sunset, and the sunset is a distinctly coloured one, as is evident by the colours on the clouds, and the very carefully painted zone of the sky getting warmer and warmer as the horizon is approached. The light in fact is so warm that the blue has disappeared from it, and almost the green. Under these circumstances there is no green light, or very little of it, to be reflected from the leaves and trees, which are not green in themselves of course, but only have the capacity of reflecting green light. We venture to think, then, that the trees in this picture are too green, and certainly greener than they would be ever likely to appear when they were backed by a sunset sky. In No. 682, by the same artist, the greenery of the trees would have been more in place, because in that picture the sunset colours are much less warm, albeit they are beautifully true to Nature, being caused by a different meteorological condition. We do not see in this year's Academy any distinct attempt to give us that glorious contrast one sometimes sees at sunset between brilliantly illuminated clouds, running through all the composite colours which are possible between red and yellow, backed by a "daffodil sky," as Tennyson calls it, or even one approaching an olive green. The nearest approach to such a green sky as this last we find in No. 990, which the artist funnily styles "Beneath Blue Skies." Surely the sky in this picture is green, and not blue.

On a former occasion, some years ago now, we ventured to put together a few notes regarding the hints that artists might glean, if they chose, in two or three hours' reading from any elementary books on astronomy about the moon. We are sorry to say that the moons in this year's Academy show that such advice still holds good, for in most cases the moons are wofully wrong. Funnily enough, there is a difference between the moons now and the moons of ten years ago. They were then far too large, now as a rule they err in an opposite direction. It may perhaps be imagined that the artist has no available means of drawing the moon to anything like the correct scale. This really is not so. If the artist has made up his mind that his picture shall contain, say, some 60° in the horizontal scale, so that six such pictures would enable him to give a complete panorama of the landscape around him from the place he has chosen to paint from, we have—provided the 60° are properly estimated—a perfect method of drawing the moon to scale, for the reason that as the diameter of the moon is about half a degree, so the diameter shown should be 1/120 of the length of the picture. We are inclined to believe that a moon of this size would really look rather too small, although, of course, it would be scientifically correct, for the reason that we have been fed upon large moons in pictures all our lives, and it is a part of our artistic education at the present moment to expect to see a large moon on canvas, and there is something uncanny about a small one, even if it is perfectly correctly painted. This artistic treatment of the moon will of course lose all its objectionable characters as the years roll by, and we shall not expect to see one thing in a picture and another thing, which the picture is supposed to represent, in the heavens.

In pictures 118 and 231 the moons would have been truer to nature if they had been slightly larger; but the worst of it is that this is not the only defect about them. Thus, dealing with 118, it is obvious that the sun is setting to the right of the picture; the moon, therefore, cannot have been full. If the artist thought he was drawing a gibbous moon, then he should have shown the imperfect edge of it away from the sun, and not below it as he has done. The fault in No. 231 is that the warm tone of the picture generally, indicates that we are somewhere about the hour of sunset; the sun has evidently not yet set, the luminosity of the picture shows that. Now we cannot get a full moon as high as the artist has represented his until after the sun has set, for a very simple reason which is known to everybody. We should like also to suggest to another artist that when he gets his picture, No. 137, back from the Academy, he should carefully take out the moon, because its presence shows that the sun is not setting, and if the sun is not setting, then the colours on the clouds are false; without the moon the picture would be entirely satisfactory to a keen observer of natural phenomena, assuming the sunset hour to be approaching, for the colours of the clouds are most beautiful. There can be no doubt, we think, that the study of cloud-forms is now not so neglected as it used to be. Some of the forms of clouds in many of the pictures this year indicate a very close attention given to them and to their floating changes by the artists; witness Nos. 459, 945, and 28.

The forms of water, too, and the illuminations of a water surface, are admirably represented in many pictures this year. The tracery of the water surface could scarcely be more exquisitely shown than in No. 118, the picture we have already referred to as possessing a most unfortunate moon. The little roller stretching nearly across 630 seems absolutely approaching us, while the view of the opening sea with the solitary sail in No. 659 positively makes one feel as if one were on a Cunarder, revelling in the fresh free air.

Although we have pointed out much that we hold to be very excellent in the way of sky and sea colour, we cannot help thinking that the chalkiness is on the increase: we never remember to have seen before so many seas and skies resembling chalk and water. This is an effect really very rarely observed in the sky, and not often in the sea, excepting close in shore, and in the absorptive properties of water we have a very good reason why it should not be so. Let the reader look at 223, 254, 274, 353, and 419.

There is no help for it, we must say a few words about rainbows. Why should an artist who has never seen a rainbow, or, if he has seen one, been so careless as not to take the trouble to look at it or to observe the order of its colours, why, we say, should he take the trouble to paint it? why does he not leave it alone? As most people know, the colours in the rainbow are regulated by a definite law—that is to say, the order of colours is the same. If we have red on one side of the bow, then we have to pass through orange, yellow, green, and blue, till we reach the violet on the other side. But in the two rainbows portrayed this year in the Academy, this order is not at all followed. One of the artists preferred to put the green between the yellow and the red, and the other thinks he has found a more excellent way. The result is that these gentlemen present us, under the guise of a rainbow, with a phenomenon which no mortal has ever seen or ever will see.

It is a matter, we should have thought, of general knowledge that a rainbow is caused by the action of raindrops upon the light which impinges upon them. In the annexed woodcut, we may imagine the beam S I a sunbeam entering a drop of water, a section of which is shown, A I I′. The beam is refracted on its entrance into the drop at I, is reflected at A, and is again refracted on emerging from the drop at I′. The light which originally entered the drop in the direction S I leaves it in the direction I′ M, and the eye, to see the raindrop, must be along the line I′ M. The observer, therefore, must obviously have his back to the sun, and the bow will appear to be at some distance above the horizon. If the sunlight could not be broken up into various colours by refraction, the bow would not appear coloured; but as refraction, which has two chances of working, does break up white light into its constituent colours, the emerging beam I′ M is coloured, and the order of colours must necessarily be the same as that which is observed by means of an ordinary prism or lustre. We begin with the warmest colours, the reds and oranges, outside the bow, the inside of the bow being formed of the cooler colours, blue and violet. This rainbow, which is the one observed under ordinary conditions, is formed by means of the rays of light falling on the outer portions of the drops, and is called the primary bow; as we see, the light suffers two refractions and one reflection in the drop.

There is another rainbow seen, when the conditions are entirely favourable, outside the former or primary one. This is called the secondary bow; it depends for its existence upon the light which falls nearer the front surface of the drop, a condition of things shown in the next woodcut, in which S I represents the light which is refracted at I, reflected internally at A, reflected internally

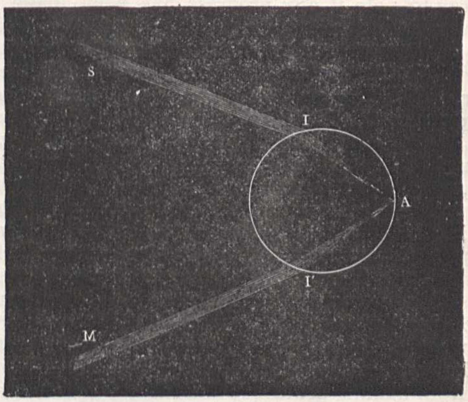

FIG. 1.—Path of light in producing primary bow.

again at B, and refracted at I′, and sent along the path I M to the eye. The eye, which receives it therefore in the line I′ M, receives it after two refractions and two internal reflections.

In this secondary bow the order of colours is reversed. We get the warm colours, the reds and the yellows, inside, and the blue and violet outside, so that when the primary and secondary bows are both seen, the two reds are together, and the two blues as far apart as they can be.

When we talk of the spectrum colours in the rainbow, it must be always understood that the appearance is not that assumed by an absolutely pure spectrum, for the reason

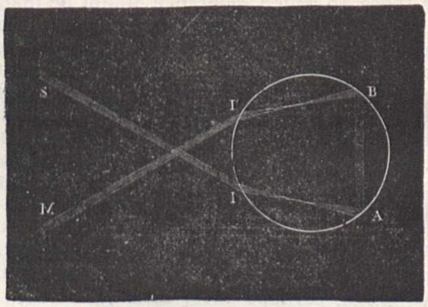

FIG. 2.—Path of light in producing secondary bow.

that the sun, the light of which is in question, has a disk of visible magnitude, and that the ray of light coming from each point of the sun is competent to produce a rainbow. Hence the rainbow is a very composite thing, and really consists of millions of spectra overlapping. The more the overlapping is intensified, the more the pure colours disappear, and hence it is that the rainbows seen when the sun is behind a cloud are very often seen without any trace of colour. The more the light proceeds from a large surface, the dimmer and less clear will the rainbow become, until at last it fades into invisibility.

An artist in painting a rainbow, then, has to consider that the colours can never be absolutely pure, and that their order is absolutely invariable; and the first thing that one must expect in a picture painted by an artist of intelligence is that this order shall not be interrupted or travestied.

In 624 a very interesting question of perspective is raised. If we imagine a room with an atmosphere very thickly laden with dust, and imagine further this room to be illuminated by a window with an ordinary window-sash: if the sun shines into the room, the sashes will cast their shadows on to the dust-laden air. As the sun is 93,000,000 of miles away, or thereabouts, the shadows of all the horizontal sashes and of all the vertical sashes will be parallel. If on the other hand, instead of letting the sun throw shadows of the sashes in this way, we imagine a strong light not far away from the window to do it, the shadows of the two series of sashes will be no longer parallel, they will diverge, and the nearer the light is to the window the more they will diverge. It is of course quite understood that in the room itself the parallel shadows cast by the sun could not appear to be truly parallel, for the reason that one part of the shadow must be nearer the eye than the other, but we cannot help thinking that the difference between this condition and the one which holds when the source of light is close to us, has not been sufficiently taken into account by the artist, so that a sun 93 yards off instead of 93,000,000 of miles would have been very much more likely to produce the effect shown in the picture.

A REVIEW OF LIGHTHOUSE WORK AND ECONOMY IN THE UNITED KINGDOM DURING THE PAST FIFTY YEARS.[1]

III.

THE growth of improvement in lighthouse towers, lanterns, and apparatus has been glanced at. The source of light, or lamps and their aliment, must now be considered. It is probable that the *phari* of antiquity were open wood fires of great size on the summit of high towers or headlands. "*Ignes*" and "*flammis*" are terms used by Pliny and others, and Statius compares the *pharos* to the moon, not to a star as a modern poet would rather do. Yet Lucan speaks of "*lampada*," and Pliny fears that the flames might be mistaken for a constellation. But in these times oil could hardly have been used, as no form of lamp known could be applied with success. For 2000 years the illuminant was mainly wood or coal. The Cordouan, in 1610, was kindled with oak logs. Coal fires were burnt at Harwich in the end of the eighteenth century. The Lizard was a coal fire in 1812. St. Bees ceased to be one only in 1822. The Isle of May remained a coal light for 181 years. It is now the single specimen of the electric light in Scotland. Sperm oil was not used before 1730, and then but on a small scale until the burners of Argand in 1783 and the reflectors of Teulère in the same year changed the character of lighthouse illumination. The Eddystone in 1759 threw its first beams over the waters from ten pounds of tallow candles, for which, in 1811, wax was substituted.

But in 1837 sperm oil was the general aliment for our catoptric lights. In that year the oxy-oil lamp was proposed by Mr. Gurney. The principle of this light, known as the Bude, was a stream of oxygen injected into an oil flame, and it has since been tried with gas flames. It was followed by the Drummond lime-light, and by ignited platinum wire and various pyrotechnic mixtures. The Bude and Drummond lights were tried by the Trinity House without successful result. In 1845 a Parliamentary inquiry on oils led to the choice of rape-seed as a substitute for spermaceti, and in 1860 vegetable oil was being used everywhere, with perhaps a little gas for small lights. The single lamp of the dioptric system was then in England and Ireland the "fountain," and in Scotland the mechanical or clockwork lamp, as used in France, both having four concentric wicks. It was with this lamp that Fresnel established his first light at the Tour de Cordouan in 1822. So far as can be ascertained, the electric spark was first practically suggested for a lighthouse in 1852 or 1853 (Holmes), or in 1854 (Watson), as will be later referred to. In 1860, Prof. G. B. Airy wrote to the Royal Commissioners on Lights:—"At present the great excellence of a lighthouse is, or may be, the optician's part. The great defect and waste is in the source of light." Coal gas had been introduced in 1837 at the inner pier light of Troon (Ayrshire), and in 1847 it was used in the Hartlepool Heugh dioptric sea-light. From 1865 to 1867, gas was proposed for lighthouses in Ireland, but not officially adopted. In the same period, mineral oil, which had become familiar to English people in domestic lighting, and had been used in French lighthouses in lamps of a single wick and apparatus not larger than the fourth order, was much discussed as a suitable illuminant for sea-lights. After a long course of official experiment and inquiry, the unreserved use of mineral oil was authorized for lighthouses on land, and the Flamborough Head was the first Trinity light to receive the new illuminant (1872). One name is here worthy of distinction. Capt. H. H. Doty may justly be regarded as the chief demonstrator of the "promise and potency" of mineral oil. He also constructed a burner with multiple wicks which produced steady and brilliant flames. This burner is not, however, novel in its elements or combinations, and other petroleum burners of equal and superior merit have since been introduced. It is not on the Doty burner itself that his reputation is best founded, but on his strenuous and intelligent advocacy of mineral oil, and on his practical application of it to a multiple burner. It is gratifying to know that his services have been for this reason recognized by grants of money from the Governments of England and France.

Since 1872 the use of petroleum has been more and more extended, and it is now a trusted and perfectly safe illuminant. Until recently the variety known as "Young's lighthouse oil" was exclusively adopted by the Trinity House, its flashing-point being not lower than 142°, its specific gravity 0·81. Later varieties of it have a flashing-point of 154°. This fluid does not rise to the level of the top of the burner, but is confined to a certain distance below, whence the cotton wicks are charged with it by capillarity, and it is the vapour or gas that is ignited. The absence of overflow leaves the tips of the burner dry and unrefreshed, and therefore subject more or less to rapid deterioration. But in the heavy mineral oil lately recommended by the Trinity House, the specific gravity is between 0·828 and 0·832 (at 60° F.), and the flashing-point is not lower than 250°. This oil, therefore, may probably be allowed to overflow the burner like colza. There is also a very useful variety, under the name of "mineral sperm," which was first introduced by the writer into harbour and ships' signal lights. The flashing-point has reached 270°.

The saving of expense in using mineral oil in a lighthouse may be understood thus. A six-wick burner of the best Trinity type consumes, when at full power, 79·4 fluid ounces, or half a gallon hourly. In a year of about 4000 hours this would cost perhaps £70. Vegetable oil in the same quantity would cost perhaps £250. There would be no appreciable difference in intensity of light, but much in favour of mineral oil in the facility of service and in the smaller consumption of wicks. *Pari passu* with the adoption of this illuminant has been the improvement in the pressure and pump lamps and their burners effected by the Trinity House and by Messrs.

[1] Continued from p. 181.

Chance. It is, above all, to Sir James Douglass that credit is due in this field. For at least eighteen years he has worked unweariedly, and in the interest of the public service alone, at the perfecting of the burners which bear his name, whether for colza, paraffin, or gas; and some striking developments have been attained by him. For instance, the typical four-wick vegetable-oil burner of Fresnel had an intensity of 230 candle-units, or 23·6 units per square inch of sectional area. The Trinity four-wick has an intensity of 415 candle-units, or 44·3 per square inch. The Trinity six-wick, perhaps the most serviceable and complete burner ever constructed, equals 730 candles, or 40·1 per square inch. The Trinity seven-wick equals 1100 candles, or 46·9 per square inch, and the Trinity nine-wick equals 1785 candles, or 49·8 per square inch. These burners are all for vegetable or mineral oil. The Trinity six-ring gas-burner equals 853 candles, or 44·4 per square inch; and, which appears to be the most powerful combination ever attained, the Trinity ten-ring gas-burner reaches 2619 candles, or 50·9 per square inch of sectional area. The admirable expanding gas-burners of Mr. Wigham are hardly less powerful. They are formed of concentric circles of jets from 28 to 108 in number, disposed so as to suit optical apparatus of several degrees of size, and weather of every degree of clearness. To this gentleman must be accorded the same pre-eminence in the skilful use of gas for lighthouses as to Capt. Doty for the skilful use of mineral oil. His ingenious combinations and contrivances, not only in regard to power, but to distinctiveness of character, are seen to great advantage in Galley Head and other notable Irish lights. It has been urged against gas flames of the largest dimensions on this system, that a portion of light escapes lenticular action, yet this very ex-focality has been found to have a useful side, for it tends to produce a glare or glow in the heavens, visible to mariners when the tower is beneath the horizon, and, in some circumstances, positively useful to them. (The electric light produces a similar effect, though in a different manner.) A more serious objection to large gas flames, especially when used in triform or quadriform series, appears to be the excessive heat, which is capable of injuring the delicate optical glass, and is hardly favourable to the keepers. It is probable that the hyper-radial apparatus just introduced may, both as relates to condensation of light and to mitigation of heat, be well suited to gas-burners of these striking magnitudes. Of the thirty-two dioptric sea-lights in Ireland, about one-fourth are successfully endowed with the gas-illuminant. Of the sixty-five in England, the Haisboro' is the only case. There is no gas in the fifty-one Scottish sea-lights, except Ailsa Craig, which has oil-gas. It should be added that the compressed mineral-oil gas of Messrs. Pintsch, and the petroleum spirit of Herr Lindberg, for the automatic lighting of buoys, have been, since 1878, tried in this country with great success.

The third illuminant, electricity, has been known in England for about thirty-five years. As generated in the magneto-machines of Prof. Holmes between 1853 and 1862, and as tried experimentally in the lighthouses of Dungeness and South Foreland, it was very small in dimension and very uncertain in character. Several forms of the light were suggested during this period, such as the voltaic arc of Watson and the mercurial electric lamp of Way. With the more effective alternating current machines, and with the larger carbons, of later years, the arc grew in power and dimension. At the present time carbons of from 25 to 40 millimetres are available, with an intensity in the focus of a light of ten times that of the most powerful gas or oil burner. The arc is thus become a most valuable resource, not merely for its unsurpassable power, but also for its focal adaptability to the usual dioptric apparatus, and to special optical combinations dictated by nautical circumstances. It is most flexible in its application. It radiates no harmful heat It has the high merit of not exacting any abnormal dimensions of apparatus, lantern, or tower. Lastly, being the most powerful in all its gradations relatively to other illuminants, it is the cheapest of all lights if the cost of establishment and maintenance be computed in terms of the units of the beam transmitted, which is the only strictly logical and practical way of treating it. For these reasons it has been chosen in France as the best illuminant for a large number of coast-lights, and it is making rapid way in Europe and America. It may therefore be safely asserted that the electric light, when it shall have been freed from its last disabilities, and shall have attained its utmost development, will, in the not distant future, be the prevailing illuminant of our own lighthouses and of the other chief lighthouses of the world.

In illustration of the power of the electric arc with suitable optical treatment, I may mention that the direct beams of the Tino light, near Spezia, were observed on April 20, 1885, by Prof. Noceti, from the hill S. Giorgio, behind Savona, at an elevation of 2733 feet, and a distance of 73 statute miles, the atmosphere being clear and under moonlight. The beams of the arc were notably brighter than those of the *lanterna* at Genoa, at one-third of the distance. Frequent observations are reported of the Macquarie light in New South Wales, at ranges of 60, 65, and 70 nautical miles, by means of reflections on the sky while the light itself is below the horizon.

The relative merits of gas, oil, and electricity, were established in the prolonged official experiments at the South Foreland in 1884–85. It has been proved that there is no appreciable *qualitative* difference between mineral oil and coal-gas as light-giving agents; and that such differences as appeared were rather *quantitative*, arising from the number and dimensions of the burners, and the modes of their collocation or superposition. It has been proved also that the electric arc (in addition to its superiority in clear weather, which was never in question) has an absolute superiority in thick weather to both gas and oil—"the greatest penetrative power in fog." Much public controversy has been excited by the Report in which conclusions like these are embodied. The fairness and impartiality of persons concerned in the investigation have even been impugned, and objection has been taken to the manner in which the electric light was presented to the observers, and to the refusal of the Trinity House to accept certain maximum arrangements called "double-triform" and "double quadriform." But to anyone reading the Report of the Trinity House (1885) with no bias toward a particular interest or a pre-conceived theory, it must appear that the inquiry was as exhaustive as it was prolonged, and that it is impossible that such names as those connected with it—names eminent in science, in engineering, and in the nautical and official world—should be associated with any other desire than the desire to shed light on a vexed technical question, and to achieve honourably and thoroughly a great public work. With regard to the exclusion of maximum combinations from the Foreland programme, it was obviously sufficient to compare gas and oil in their respective primary burners, multiplied or combined in such a way as, while insuring equal terms or nearly so, to reproduce the actual or allowable conditions of a lighthouse; and nothing would seem to be gained by augmenting the rival elements *pari gradu* to ampler and ampler bulk regardless of all else. The inter-relation of the numbers one, two, three, is not affected, or very slightly so, by raising them to two, four, six, or to four, eight, twelve. And although the highest power of the initial flame or the emerging beam were reached according to the opinion of the moment, the next day might suggest a still higher power, until it became clear that we might as well revert to the old beacon-fire on the headland, for indeed with unlimited tar-barrels or profuse pine-logs a light *could* be kindled exceeding everything yet achieved by gas, oil, or electricity, and visible not only on the horizon, but across half the midnight sky.

Phonic signals as auxiliary to luminous signals have engaged the attention of our lighthouse authorities from dates previous to 1837, and almost continuously from 1848 to 1875. The early instruments were the bell, the gun, and the gong, with sometimes an explosive such as a rocket. Between 1848 and 1850, Mr. G. Wells produced his patent "fog screamer" (by atmospheric pressure), which, however, did not meet the approval of the Trinity House, who, in 1853, considered that a good-sized bell struck sharply by machinery surpassed any mode yet tried. During the next ten years experiments on fog-signals were carried on in France, and in 1864 there was an important investigation by the Government of the United States. In 1872 a Committee of the Trinity House visited that country and Canada, and tested the merits of the new sound instruments in use, chiefly the Daboll horn actuated by air, and the siren actuated by steam. The Canadian and American steam-whistles and the New York siren, together with air-whistles, air-trumpets, and some guns, were next employed in the most complete scientific and practical inquiry ever held into the laws that regulate the passage of sound through the atmosphere, and into the mechanical agents most suitable to be adopted. The experiments were conducted by the Trinity House at the South Foreland in 1873-74, under the superintendence of Dr. Tyndall, who was able to demonstrate that fog or heavy rain is permeable by sound to a degree never before understood, and that optical transparency might be combined, even as cause and effect, with acoustical opacity or turbidity, and *vice versâ*. These results attracted much attention, and although Prof. Tyndall's inductions as to homogeneity or non-homogeneity of the atmosphere have been to some extent questioned, the large body of facts on which they rest has been still further enlarged and confirmed. It follows that a fog dense enough to quench all light may permit sound to be transmitted with unimpaired distinctness; and where the sound, either by alternations of pitch or of interval, is made a substitute for the characteristics of a light-signal, a very valuable secondary set of signals is realized. Of the instruments tried at the South Foreland the siren was found to be the most effective in almost all circumstances. This instrument was the work of Mr. Brown, of New York, to whom a simple and powerful form of caloric engine is also due. It consists of a trumpet about 17 feet long, increasing from 5 to 27 inches in diameter, having two disks in it, one fixed and one rotating, with radial slits in them. The rotation is from 2000 to 2500 times in a minute, steam at from 70 to 80 lbs. pressure being supplied. A note of varying pitch and intensity, audible at distances from 3 to 10 miles is thus generated. The siren in another form was improved by Dove and by Helmholtz, and previously by Cagniard de la Tour, who gave it this name, presumably on the *lucus a non lucendo* principle. It is now employed at many first-class land lighthouses where space exists for the needful steam or caloric motor. Truly for the help not the harm of the mariner, in the words of the poet, "*Siren assuetos effudit in æquore cantus.*" It is possible that the recent disaster off Dieppe might have been averted if the *Victoria*, moving doubtfully through the fog, could have heard the steam-trumpet on Cap d'Ailly, which seems to have been disabled at the critical time. Both the range of the siren and the facilities for working it have of late been enhanced by the methods of Mr. Charles Ingrey, who, by employing air compressed by engines of 40 horse-power, the air-pressure being 80 lbs. per square inch, has, in the case of the Ailsa Craig establishment, produced from two sirens a sound audible, it is said, at a distance of 20 miles in calm weather. One of these instruments gives single blasts of 5 seconds duration, the other a high, low, and high note in series, each of 2 seconds, with intervals of 2 seconds between them, followed by 170 seconds of silence. This is the phonic analogue of a single-flashing and of a group-flashing light respectively. The compressed air is conveyed from a considerable distance to the siren-house, and Mr. Ingrey is confident that he could work the instrument from an engine placed 10 miles away. After the South Foreland experiments of 1874, the Trinity House proceeded to improve the gun as a sound-signalling agent. It now ranks as second to the siren alone. Gun-cotton is proved to be a more effective charge than powder, and it has been supplied with the gun to a few lightships; but the siren is for principal stations, and the gong, or bell, or an explosive mixture, for others.

The details so far given, though necessarily incomplete, illustrate the notable progress in lighthouse design and construction attained in this country since the accession of our Queen, and not less do they show the increasing number of the lights established on our shores. Along with France and the United States—and due honour must be accorded to the eminent men representing them—Great Britain has proceeded steadily in the path of investigation and experiment. And here the labours of the celebrated Royal Commission of 1859-60 on lights, buoys, and beacons should not be overlooked. This Commission collected from all maritime countries and from the leading authorities in official life, in engineering and nautical science, in mathematics and physics, a vast body of evidence which to the careful student will not prove the *rudis indigestaque moles* it at first sight appears. Some of the recommendations of the Commission have been fully carried into effect during the last quarter of a century, *e.g.* the proper adjustment of optical agents to the flame and to the sea horizon, the development of lamps and burners, the provision of reflectors, testing of foci, &c. The conclusions also of the Commissioners on the complicated and anomalous system of lighthouse government formulated by the Merchant Shipping Act of 1854 have never been impugned; and the expediency of a central Lighthouse Board as suggested by them, and as indeed had been suggested by the Parliamentary Committee of 1834, has become more and more evident down to the present day.

But while Great Britain has, in common with France and the United States, pursued this path of inquiry and reform, she has distanced these countries altogether in the results of research and the realisation of improvement. The splendid gift of the dioptric system was made to the world by the genius of Fresnel, yet little has been added to it by his countrymen. The most solid and important additions and applications are the work of Scottish and English engineers, whether in the optics or the mechanics of lighthouses, whether in oil, gas, or electricity. And the gift of Fresnel has thus been returned enhanced three-fold to France and to the world. How it has been received is apparent by this one indication: the yearly statistics of our Admiralty comprise forty lighthouse notices issued to mariners in 1862, and 311 issued in 1886, the subjects of these notices being mainly new lights, and the new lights being mainly on the most modern lenticular system.

NOTE.—Since the above was written the small circle of men associated with lighthouse illumination has been broken by the death of its most distinguished member, Thomas Stevenson, who, during the whole of the half century under review, did more than any other to multiply for engineers the resources of his science, and to diminish for all the world the manifold perils of the sea.

The extraordinary power of the electric light has been referred to in connexion with the apparatus of Isola del Tino. In a recent communication to the *Standard* from "C. P. S." from Via Reggio, further testimony is given to this power in clear weather, but a far more important and controversial point is conclusively dealt with. The writer says:—"Again, though dimmed by heavy rain and thick fog, as it has been during the last few nights, the triple flash is always clear and unmistakable, and then produces, through the quasi-opaque atmosphere, and at a distance of thirty miles, the effect of the blurred disk of the moon on a small scale. This remarkable penetration power of the Tino light is conclusive proof, not only of how admirably it is designed and suited to its essential purpose as a guiding light under the peculiar atmospheric conditions of the Mediterranean, but also how hazardous it would be to dip—viz. to divert such a light, as has been suggested by some—from the horizon to the nearer sea in foggy weather, forsooth according to the *bene placito* of the man in charge, on the presumption that in such weather the luminous rays could not reach the horizon, and would therefore be wasted. This presumption is wholly fallacious in the Mediterranean, for in the Bay of Spezia, owing to its proximity to the Apennines, the rainfall is much greater than in other parts of the Tyrrhenean Sea, and banks of land fog can often be seen hanging over the bay and Tino, when the horizon as far as Leghorn, Gorgona, and even Corsica, is perfectly clear."

June 1887. J. KENWARD.

REPORT OF THE BOARD OF TRADE ON WEIGHTS AND MEASURES.

ONE of the many official Reports which are laid annually before Parliament, but which unfortunately are not so carefully read by the general public as they might be, is a Report by the Board of Trade on their proceedings and business under the Weights and Measures Act of 1878. In Report No. 9, Sess. II., 1886, there is something of scientific interest to which we would invite the attention of our readers.

The only two units from which all Imperial measures and weights are derived are, as is well known, the yard and the pound, and material standards of these two units are deposited with the Board of Trade. The Act provides that an accurate copy of each of these standards is to be made, and an account of the verification of a new copy of the yard measure is given in the present Report. The results of the comparisons of the new yard, P.C. VI., with the Imperial standard yard No. 1, show that it differs little from the original standard:—

$$\text{P.C. VI.} = \text{No. 1} - 0{\cdot}0000034 \text{ inch. } t = 62^\circ \text{ F.}$$

There are no two primary standards between which our present scientific methods cannot measure some difference, but the above two standards would appear to be as nearly alike as it is possible to make them.

In determining the rate of expansion by heat of the new standard yard (which is a bronze bar 36 inches long), it was found that with a rising temperature, the new bar expanded 0·000356 inch for 1° F., but with a falling temperature it contracted at a lesser rate, 0·000343 inch for 1° F. It is not stated whether this curious difference in the rate of expansion, as determined when the temperature is alternately rising and falling, is owing to the march of the mercurial thermometers or to other causes. Some doubt has arisen as to the rate of expansion of the metal (bronze) of which the Imperial standard was made. The thermometric expansions stated in the Report of the Astronomer-Royal on the construction of the Imperial standard (*Phil. Trans. Roy. Soc.*, part iii., 1857, p. 61) do not agree with those stated by Colonel Clarke and Sir Henry James in their Report on the comparisons of standards of length (1886). The actual rate of expansion of the Imperial yard was, in fact, not determined by the Standards Committee in 1857, but was assumed to be the same as that of other similar bars of the same metal. The more recent experience, however, is that no two bronze bars expand by heat at precisely the same rate, although they may be of the same dimensions, form, and material. The co-efficient of expansion of an alloy is slightly affected by differences in the age of the alloy, by its being subjected to extreme variations of heat and cold, and by peculiarities in molecular condition.

With reference to the metric system, we are glad to see that during 1886 standards of metric weight and measure were verified for certain authorities for use in scientific research or otherwise. It would, however, appear that in Japan, in the competition for commercial acceptance, the British system is at present outstripping the metric system.

The legal equivalent of the metre is 39·37079 inches, but, as some doubt has been expressed as to the scientific accuracy of this equivalent, Prof. W. A. Rogers, of Colby University, has undertaken to construct for the Standards Department a subdivided standard yard and metre, on which the precise length of the two standards shall be marked off, so that an exact inter-comparison of the two standards may, as far as practicable, hereafter be made at London and at the Bureau International des Poids et Mesures, at Paris.

In this Report we have for the first time complete and trustworthy information as to the standard weights and measures in use in China and Japan, Her Majesty's ministers at Pekin and Tokio having obtained the information from the native Governments and through the different local consuls.

During the year 1886 the Standards Department was specially engaged in the re-verification of the accuracy of its own standards, and in the issue to local authorities of some suggestions with reference to the duties of inspectors of weights and measures. Amongst the re-verifications particularly referred to we notice a memorandum on the re-verification of the gas-measuring standards, a memorandum which shows the several conditions necessary for the accurate measurement of gas used for lighting purposes. The accuracy of the unit of volume, the cubic foot, is made to depend on the Imperial standard pound, and not on linear measurement. Experience has hitherto shown that the determination of the weight of a cubic foot of distilled water may best be made by means of a round vessel which holds a quantity of water equal to 62·321 lb. avoirdupois at 62° F., rather than by a vessel of rectangular shape, which might be made to measure one foot in each of its dimensions. In this memorandum reference also is made to a slight difference in the methods of determining the zero, or freezing-points, of thermometers. It is, for instance, uncertain how long a thermometer should remain in melting ice or snow before its precise freezing-point is noted. At the Bureau of Weights and Measures at Paris, for instance, the thermometer is only left in the pounded ice just long enough for it to reach the maximum of depression. With thermometers made of hard glass it is stated to be desirable not to hurry the observations—the thermometers remaining long enough to allow the use of a micrometer, and several observations to be taken; but with other kinds of glass it is found to be desirable to be as quick as possible. This practice is also stated to be adopted at the Standards Offices at Berlin and Washington. On the other hand, at Kew the freezing-point of a thermometer is not observed until the instrument has been completely buried, both bulb and stem, up to 32° F., or 0° C., in well-pounded block ice for a period of not less than a quarter of an hour, care being always taken in cold weather to insure the whole of the ice being in a melting condition during the experiment by pouring a small quantity of tepid water over it from time to time.

Unlike the determinations of the rate of expansion of gas, there has not been made any determination of the rate of expansion of water which in exact experiments might be accepted as conclusive, and hence, in determining the weight of a volume of water at any given temperature, the Standards Department have been advised to adopt a mean result from several selected determinations, as those of Despretz, Kopp, and Pierre.

In many technical works, measurements of gas are erroneously referred to the temperature of 60° F., and not to the legal temperature of 62° F., at which temperature alone the standard foot contains 12 inches; the standard gallon 10 lbs. weight of water; and the standard pound 7000 grains. It would appear that an error originally committed in certain hydrometer tables in taking 60° F. instead of 62° F., has been followed by many chemical authorities.

The weight of a cubic foot of ordinary air has been still taken by the Standards Department after the determinations of Regnault, as corrected by Moritz, Broch, and Agamemnone. The amount of carbonic acid present in ordinary air has been taken, after the inquiries of Parkes and Angus-Smith, at 6 volumes in every 10,000 volumes of air. If double the quantity, 12 volumes, is present, as is sometimes the case in common rooms, it will make a difference of about 0·18 grain in the weight of the cubic foot of air. Ordinary air is still taken, after Regnault, as being two-thirds saturated with moisture.

In calculating the true weight of any given volume of air or of gas we may, of course, on very rare occasions have to allow for the accelerative effect of the force of gravity at the latitude of the place where the air or gas is weighed, as well as for the height of the place above sea-level. The normal latitude adopted in all such experiments is that of 45° at sea-level.

For instance, the weight in grains of a cubic foot of ordinary air ($t = 62°$ F., B = 30 in.) at London (lat. = 51° 29′ 53″), at Edinburgh (lat. = 55° 57′ 20″), and at Dublin (lat. = 53° 20′ 38″), has been taken as follows:—

	Dry air.	Air two-thirds saturated.	Moist air saturation = 1.
	Gr.	Gr.	Gr.
Edinburgh	534·42	531·92	530·68
Dublin	534·30	531·81	530·56
London	534·21	531·72	530·48

From time to time, on the application of local authorities, suggestions are issued by the Board of Trade as to the best modes of testing the weights, measures, and measuring instruments used for commercial purposes. In this country the local inspectors are not bound to follow official instructions as they are in other countries, but are free to carry out their technical work in such a way as the Justices and Town Councils may approve. It is therefore only by the issue of such official suggestions that uniformity of local practice can be at all reached, and some amount of co-ordination and local effectiveness thereby secured. It is perhaps to be regretted that there is in this country no central authority like the Normal Aichungs Kommission of Germany or Austria to give force and life to the whole local system; not that we would have the local officers in this country drilled to the dull sameness of official uniformity in the way they are drilled by some Continental Governments, but the absence of a proper scientific training by our local inspectors often leads to complaints from traders and manufacturers. By these official suggestions the Board of Trade endeavour, therefore, to educate local officers in their technical work and to keep them so far in touch with modern progress.

The present Report contains a paper on the testing of weighing-machines, which should be of really practical use to the local officers, for it is the first time that any instructions have been published as to the mode of testing such machines.

Amongst other appendixes to this Report we find papers relating to the well-known model apparatus, designed by Sir F. Abel, for testing the flashing-point of petroleum; abstracts of returns from local officers; notes on the sale of coal by weight and the sale of intoxicants by measure—with reference to which it would appear that there is more petty fraud than ever amongst traders; and a note on the average current weight of the sovereign. In the latter note reference is made to a number of weighings of gold coin, which have been recently made at the leading Banks in London. The results of these weighings show that most of the gold coinage in circulation has really ceased to be legal tender as to weight. Nearly all the coins which were weighed were found to be slightly below the least current weight allowed by the Coinage Act. If the present law, which requires receivers of light gold coins to cut or deface them, were really obeyed, then it would appear from this note that six sovereigns out of every seven ought strictly to be cut or defaced. This seems to be a worse state of things than when Prof. Jevons made his well-known report on the metallic currency of the United Kingdom in 1868.

THE GERMAN METEOROLOGICAL OFFICE.

A HISTORY of the Royal Prussian Meteorological Institute from the time of its establishment in 1847 until its re-organisation in 1885, by Dr. G. Hellmann, has just been published in the year-book of the Institution, "Ergebnisse der Meteorologischen Beobachtungen im Jahre 1885" (Berlin, 1887, 246 pages, large 4to, with plates). Dr. Hellmann is well-known to students of meteorology by many very valuable articles, and especially by his laborious compilation of a "Repertorium der Deutschen Meteorologie," containing a list of the articles, inventions, and observations in the domain of Meteorology and Terrestrial Magnetism in Germany from the earliest times down to the year 1881 (Leipzig, 1883, 995 pages, large 8vo). The kingdom of Prussia was relatively late in organising a regular system of observations, Baden and Bavaria in Southern Germany having established well-appointed services before the end of the last century; and Würtemberg followed with its system in 1821–2. The want of trustworthy data for Northern Germany was much felt by Baron A. von Humboldt at the time of the construction of his first isothermal charts in 1817, and the establishment of the service in Prussia was due to the urgent representations which he made to the present Emperor. In 1847 a system of 25–30 stations was established under Dr. Mahlmann, and observations were taken at the hours of 6, 2, and 10; these hours have been generally adhered to both in Germany and Austria down to the present time. Before commencing operations, all the stations were duly inspected, and suitable observers selected, mostly from teachers in the upper schools. While neither instruments nor remuneration are provided for such observers in this country, in the Prussian system an annual allowance, varying from about £7 10*s.* upwards, according to circumstances, is made to many of the observers, together with an outfit of instruments. The result of these arrangements has been that probably in no other system upon the globe have so many useful works been published by the various observers, upon whom generally devolved the task of working up their own observations. Dr. Mahlmann having died suddenly on one of his tours of inspection, his work was taken up in April 1849 by the late eminent Prof. H. W. Dove, of the University of Berlin, and his first care was to revise the observations hitherto taken and to publish them in a first Report of the Observations taken in 1848–9. The publication of this Report induced several other states to join the Prussian system, many of the observers now taking up the work without remuneration, and this active co-operation enabled Dove to publish for 1855, and for subsequent years, a summary of observations for each month of the year for Northern Germany, and in 1858 a first sketch of the climatological conditions based upon ten years' observations. Prior to this publication these conditions were almost unknown for Prussia. Some of the stations were inspected yearly by Dove, but strange to say, it is stated that not a single Report of these inspections is to be found in the archives of the Institute. Among the numerous treatises by Prof. Dove, that best known is his work on the "Law of Storms," which was translated and adopted in this country. After Dove's death, in 1879, the Institute introduced the French measures in its publications, and adopted generally the recommendations of the various International Congresses, to which innovations Dove himself had always been averse, and instruments with new scales were necessarily supplied to the stations. In 1882 Dr. Hellmann was intrusted with the *ad interim* direction of the Institute, and many additional stations, especially for rainfall, were added to those which already existed, and finally (in 1885) the Institute was placed under the able superintendence of Dr. W. von Bezold, formerly director of the Bavarian system, with Drs. Hellmann, Assmann (also Director of the Magdeburg Observatory), Kremser, and Wagner, as principal assistants. The first volume of the new office has just appeared, and contains the observations at 271 stations during the year 1885 (246 pages, 4to, and 6 litho. tables), and also lists of all observations made since 1847. The stations are still very unequally distributed over the Empire, and no doubt improvements will be made in this respect, from time to time. It is plainly shown from the tables that while an open country position is most suitable *meteorologically*, yet for *duration* of the observations the large towns are preferable. These observations formerly appeared in the "Preussische Statistik," and in the publication of the Deutsche Seewarte, but will henceforward form an independent work. It is proposed in future to issue the tabular portion in quarterly volumes, and to publish pamphlets at irregular intervals under the title of "Abtheilungen," containing papers and discussions of a general nature. The Deutsche Seewarte at Hamburg is an independent Institution, dealing chiefly with maritime meteorology and weather telegraphy. J. S. HARDING.

THE HEIGHT OF SUMMER CLOUDS.

A KNOWLEDGE of the heights and movements of the clouds is of much interest to science, and of especial importance in the prediction of weather; the subject has therefore received much attention during recent years from meteorologists, chiefly in this country and in Sweden. In the last published Report of the Meteorological Council for 1885-86 will be found an account of the steps taken by that body to obtain cloud-photographs; and in the *Meteorologische Zeitschrift* for March last, MM. Ekholm and Hagström have published an interesting summary of the results of observations made at Upsala during the summers of 1884-85. They determined the parallax of the clouds by angular measurements made from two stations at the extremities of a base of convenient length, and having telephonic connexion. The instruments used were altazimuths, constructed under the direction of Prof. Mohn, specially for measuring the parallax of the aurora borealis. A full description of these instruments and of the calculations will be found in the *Acta Reg. Soc. Sc. Ups.* 1884. The results now in question are based upon nearly 1500 measurements of *heights*; the *motions* will form the subject of a future paper. It was found that clouds are formed at all levels, but that they occur most frequently at certain elevations or stages. The following are, approximately, the mean heights, in feet, of the principal forms:—Stratus, 2000; nimbus, 5000; cumulus (base), 4500, (summit) 6000; cumulo-stratus (base), 4600; "false-cirrus" (a form which often accompanies the cumulo-stratus), 12,800; cirro-cumulus, 21,000; cirrus, 29,000 (the highest being 41,000). The maximum of cloud-frequency was found to be at levels of 2300 and 5500 feet. Generally speaking, all the forms of cloud have a tendency to rise during the course of the day; the change, excepting for the cumulus-form, amounting to nearly 6500 feet. In the morning, when the cirrus clouds are at their lowest level, the frequency of their lowest forms—the cirro-cumulus—is greatest; and in the evening, when the height of the cirrus is greatest, the frequency of its highest forms—the cirro-stratus—is also greatest. With regard to the connexion between the character of the weather and the height of the clouds, the heights of the bases of the cumulus are nearly constant in all conditions. The summits, however, are lowest in the vicinity of a barometric maximum; they increase in the region of a depression, and attain their greatest height in thunderstorms, the thickness of the cumulo-stratus stretching sometimes for several miles. The highest forms of clouds appear to float at their lowest levels in the region of a depression. The forms of clouds are identical in all parts of the world, as has been shown in papers lately read by the Hon. R. Abercromby before the English and Scottish Meteorological Societies.

IVAN POLYAKOFF.

RUSSIA has lost one of her most promising men of science in Ivan Polyakoff, who died lately at St. Petersburg, from hepatic disease, at the age of about forty. He was born in the small village of Transbaikalia, on the Argun, of Cossack parents, descendants from the earlier settlers of Siberia, and received his first education in a military school for sons of soldiers and Cossacks at Irkutsk—a very limited education indeed. As his parents were poor, and life in his native village offered no attractions, he accepted the position of teacher at the same school where he had been educated. Zoology and botany became the sciences of his choice A large park belonging to the Governor, close by the military school, peopled with a variety of birds and insects, became the first field of his researches. As the spring came, he would spend the day in the garden, sometimes extending his excursions to the neighbourhood of Irkutsk, where so much is to be learned. He wrote down his observations, and published them in the *Irkutsk Gazette*. From the very first lines of his description one is struck by a remarkable feature of Polyakoff's mind—a feature which is to be found in all his later writings, and which cannot but be highly appreciated by a true naturalist: it is the simplicity of his conception of the animal world; I should say his intimacy, his familiarity, with every bird or animal he describes. He *understood* them. One must be born in a lonely Siberian village on the confines of the civilized world, at the border of the uninhabited Gobi steppe—the Argun is such a border—to be always in so close a contact with Nature.

Early in 1866 I was going to make a great journey to find out the long-searched-for route from the Lena gold-washings to the steppes of Transbaikalia. A topographer accompanied the Expedition; I undertook the geological exploration; for the botanical and zoological I invited Polyakoff to join us. We crossed the region from the Lena to Tchita, and thus Polyakoff and I were able to make a section of the backbone of the Asiatic continent, with its high and lower plateaus, their border-ridges, and the Alpine regions which fringe them. A zoologist like Polyakoff was thus enabled to obtain an insight into the whole of the Siberian fauna, as dependent upon orographical features. His descriptions of the fauna and flora of the region, especially with regard to the dependence of animals and plants upon their surroundings and their mutual interdependence—he excelled in that kind of research—are a most valuable contribution to the geographical zoology and botany of a wide region. His collection of plants was described by our friend the late Dr. Glehn.

Next year, Polyakoff made another little journey to the upper Irkut valley, from which he returned with something quite new—namely, a rich collection of stone implements. There he studied the actual position of the encampments of our Stone-Age ancestors, and the general surroundings of their life. Afterwards, wherever Polyakoff went—to Olonetz, on the Volga, on the Ural, or to Saghalien—he had only to take a short walk in the region he proposed to explore to have a general idea of it. Then he took a shovel, or invited somebody with a shovel, and indicated the place where some digging ought to be done, and stone implements (Neolithic) never failed to be found. His collections are as numerous as invaluable.

In 1868, he entered the St. Petersburg University—not without some difficulties on account of the Latin examinations—and the late Dean of the University, the much-regretted Prof. Kessler, at once perceived that he would have in Polyakoff a first-rate naturalist, and showed him much attention. Polyakoff's thesis for the degree of Doctor of Sciences—a monograph on the cartilaginous fishes—received high praise, and as soon as he was out of the University, he was appointed Conservator of the Zoological Museum of the Academy of Sciences at St. Petersburg.

After that time Polyakoff was almost always out on some expedition sent either by the Academy or by the Geographical Society. He explored the Olonetz region, the middle Volga, the lower Obi region, and recently he was sent by the Academy of Sciences on a long exploring journey to Saghalien and the Pacific littoral. It was on his return from this last journey that he fell ill at St. Petersburg, where he died in a hospital. A friend who learned of his illness, and went to visit him at the hospital, came too late.

His death is the more a loss for science, as he was going to work out in detail the exceedingly rich zoological and anthropological materials which he had collected during his last journeys. Only preliminary reports of these journeys have been published. Part of his researches on the Stone Age have been embodied in Count Uvaroff's work; others have appeared in the publications of the Academy of Sciences, the Russian Geographical Society, and the St. Petersburg University Society. His preliminary report on the Obi journey (containing an admirable description of the Ostiaks, whom he thoroughly understood) has been translated into German; and there is also a German rendering of his preliminary report, or rather letters, on Saghalien. But most of his observations remain unpublished. It is even doubtful whether his field note-books contain all his observations and generalizations, and whether they were kept in such a state as to render publication possible.

In zoology, Polyakoff's name will remain associated with the description of the *Equus prjevalski*, a separate species established by him, which is the real ancestor of our common horse, discovered by Prjevalski in the Alashan Mountains of Central Asia.

NOTES.

THE dinner given to Prof. Tyndall is going on at Willis's Rooms as we go to press. The hosts number more than two hundred, and many of the most eminent men in the country are present.

ON April 12, 1886, the Local Government Board appointed a Committee to inquire into the efficacy of M. Pasteur's treatment of hydrophobia, and into any dangers which might be connected with its employment. The Committee consisted of Sir James Paget, Dr. Lauder Brunton, Dr. Fleming, Sir Joseph Lister, Dr. Quain, Sir Henry Roscoe, and Prof. Burdon Sanderson, with Prof. Victor Horsley as Secretary. Dr. Lauder Brunton, Sir Henry Roscoe, and Dr. Burdon Sanderson, with the Secretary, visited Paris in order to study M. Pasteur's methods; and after their return Prof. Horsley conducted a series of experiments with a view to the settlement of certain points about which he and his coadjutors had felt some doubt. A copy of the Report of the Committee has been sent to the *Times*, and it appears that the Committee unanimously express confidence in M. Pasteur's system.

THE sixteenth meeting of the French Association for the Advancement of Science will be held at Toulouse from Thursday, September 22, to Thursday, September 29 next. Notice of intention to be present at the meeting should be given to the Secretary of the Association, 4 Rue Antoine-Dubois, Paris, before July 15.

THE *Evening Standard* of Tuesday is our authority for the statement that addresses from the Church of Ireland, the Metropolitan Board of Works, *the Royal Society*, and the Ancient Order of Foresters, were presented to the Queen on Monday last. Let us hope that this is not true.

THE third annual general meeting of the Marine Biological Association took place on Friday last in the rooms of the Linnean Society, Burlington House. Prof. Flower presided, and among those present were Mr. Thiselton Dyer, Mr. Crisp, Prof. Bell, Prof. Charles Stewart, Prof. Ray Lankester, and Sir John Staples. The report for the past year stated that the Council had devoted attention chiefly to the superintendence and fitting of the laboratory at Plymouth, and to preparations for the work of the Association in connexion with that laboratory. It is expected that the laboratory will be ready for partial occupation in the present summer, but the tanks and circulation of sea-water cannot be completed for some months to come. The Council had decided to issue a journal, which might serve not only for the circulation of the official publications of the Association, but also as a means of inquiry and exchange of information among those who are interested in marine biology in its relation to the sea fisheries of the United Kingdom. A first-rate biological library was one of the most important appliances which the Marine Biological Association must possess in its Plymouth laboratory. The Council trusted that the members and friends of the Association would assist in the formation of such a library by gifts of books. The Association was willing and anxious to co-operate with individuals or associations in any part of the British Islands who were engaged in the study of the natural history of marine fishes or in researches in marine biology. The Council had to record with deep regret the death of one of the vice-presidents of the Society, Mr. George Busk. Some formal business having been despatched after the adoption of the report, the meeting concluded with a vote of thanks to the chairman for presiding.

A SPECIAL general meeting of the Fellows of the Royal Horticultural Society was held on Tuesday "to consider the results of the negotiations and inquiries which have been made by the Council as to the future maintenance and housing of the Society." Sir T. Lawrence, who presided, said the Council thought it would be wise as soon as possible to carry on their operations at Chiswick; and this view met with general approval. The meeting adopted a resolution requesting the Council to take such steps for the housing and maintenance of the Society as might appear best calculated to preserve its character and utility and promote the horticultural interests committed to its charge, and insisting upon the importance of immediately taking steps to secure accommodation for the Society at the close of the year, either of a permanent or temporary character, in some central situation in or near the City.

ON Jubilee Day the Royal Gardens, Kew, were visited by 31,000 people.

THE *Meteorologische Zeitschrift* for June contains the first part of a comprehensive discussion by Dr. W. Köppen, of the Deutsche Seewarte, on the nomenclature of clouds. The author asks whether the same cloud seen from different sides should receive different names; for instance, when seen from the front, sideways, from behind, above, or below; or, whether the classification should refer generally to the properties observed in a particular cloud, especially as regards its density and dimensions. The *apparent* form plays an important part in Poey's classification, but Dr. Köppen shows that it sometimes leads to erroneous conclusions. The classifications of Hildebrandsson, Ley, Weilbach, and others, receive especial notice, but no reference is made in this first article to Mr. Abercromby's recent researches.

THE Editorial Committee of the Norwegian North-Atlantic Expedition (1876-78) have published the eighteenth volume of their General Report (Christiania, 1887, pp. 209 and 48 plates). The memoir in question has been edited by Prof. H. Mohn, Director of the Meteorological Institute at Christiania, and deals especially with the depths, temperature, and circulation of the North Ocean, and to some extent with the winds and atmospheric pressure. The region embraced lies between Iceland and Norway, and extends northwards as far as Spitzbergen. The currents naturally receive much attention, and Prof. Mohn states that he has sought to explain the motion of the water as produced alike by the normal winds and by the difference in the density of the water; and he points out that, while the former cause predominates, the latter too has full significance. The maps are very clear, and the explanatory text is written both in Norwegian and English, as in the previous volumes.

THE first of the vessels of the Norwegian seal-hunting fleet have returned to Hammerfest from the Arctic regions, and the captains report that the ice-belt this spring extended far south of Spitzbergen. It appears from their reports that when they left the ice-fields no vessels had succeeded in reaching that island. Seals were very plentiful, and nearly all vessels have full cargoes.

THE three courses of Burnett Lectures on "Light," delivered by Prof. G. G. Stokes at Aberdeen in 1883, 1884, and 1885, have now been issued in a single volume belonging to the well-known "Nature Series." As we had something to say about each of these courses at the time of its publication in a separate volume, we need only remind our readers that the first course deals with the nature of light, the second with light as a means of investigation, the third with the beneficial effects of light. On this last subject, Prof. Stokes says in the preface to the new volume:—"The benefits derived from light, which form the subject of the third course, are, it might have been supposed, too obvious to require mention. Yet few, perhaps, have been in the habit of contemplating these benefits as a whole, or have perceived how far-reaching and of what vital importance are the advantages that we derive from light, if we include in that term not merely what the eye can perceive, but all that in its physical nature differs from visible light only in the way in which light of one colour differs from that of another colour."

THE "Queen's Jubilee Atlas," which we have received from Messrs. George Philip and Son, contains an excellent series of maps, those relating to the British Empire being especially good. Each map is accompanied by a short explanation, with descriptive and historical notes and statistical tables. A physical map of England is given showing the coal-fields and the heights of all the mountains; this is followed by three separate maps of the British Isles showing the railways alone.

MESSRS. GEORGE PHILIP AND SON have also issued a "Handy-Volume Atlas of the World," containing 110 maps and plans, with complete index, and statistical notes, by Mr. J. F. Williams. The little volume has been carefully prepared, and is the first of a series designed to present all essential geographical information in a handy and accessible form.

AMONG recent publications in Paris we notice the "Éléments de Médecine suggestive" of MM. Fontan and Ségard, in which the authors give numerous illustrations of the effects of hypnotism in disease, whether mental or physical; a pamphlet, by Dr. Servier, on the Val de Grace, the military hospital in Paris, comprising the history of the buildings and of the institution; and a book by M. Ed. Dreyfus-Brisac, on "L'Éducation nouvelle," a series of studies well worth the attention of those who take some interest in the present evolution of public spirit concerning educational matters in France.

M. G. PRUVOT, *maître de conférences* in the Sorbonne, has recently issued a course of lectures on "Worms and Arthropoda." The lectures were delivered by him in 1885–86. The work is profusely illustrated.

THE *Archives Slaves de Biologie*, a periodical containing only Slavonic work in biology, are publishing a long series of papers by Danilewsky on the Hæmatozoa of Reptiles and Birds.

A FULL account of the New Zealand Industrial Exhibition, 1885, is presented in an Official Record, a copy of which has been sent to us. The facts are brought together in a way that will facilitate comparative study of the progress of the colony in the various arts and manufactures, and the volume will be of service to those who may undertake to organize any future exposition of the industrial resources of New Zealand.

AN elaborate synopsis of the North American Syrphidæ, by Dr. Samuel W. Williston, has been issued as the thirty-first Bulletin of the United States National Museum. Dr. Williston explains that he has given especial attention to this family since he began his dipterological studies eight years ago, and that he has collected a large part of the species either in New England or in the West. The types of all but two or three of the new species described by him, together with his entire collection in this family, will be preserved in the National Museum for future reference and revision.

THE Manchester Microscopical Society has just issued its Transactions and Annual Report for 1886. The volume contains a valuable address on "Fresh-water Animals," by the President, Prof. A. Milnes Marshall, F.R.S., and papers and communications read by the members. A short paper by Mr. Robert Parkes may, perhaps, suggest to some readers a pleasant way of spending a few of the approaching holidays. In this paper Mr. Parkes describes a dredging excursion he made some time ago to Lamlash Bay, Isle of Arran, in company with two friends. The excursion was very successful, and Mr. Parkes was able to exhibit to the Society some of the specimens he had secured. He assured the members that dredging was not a very expensive pursuit, to be followed only by the use of steam launches and a large staff. They could see by the collection before them that good results might be obtained by two or three joining together and dredging from an ordinary rowing-boat.

THE fifth volume of the Journal of the Liverpool Astronomical Society has just been issued. It contains many papers, notes, and reviews, and has some good illustrations.

BY permission of the President and Council of the Royal Astronomical Society, the annual general meeting of the Liverpool Astronomical Society will be held at Burlington House, London, on Friday, July 8.

THE problem of protection against yellow fever by inoculation seems in a fair way to solution by the Brazilian doctor Freire, who has been seven years at work on the subject. According to a recent account, the number of persons already inoculated is 6524. There died from yellow fever in Rio de Janeiro, between January 1885 and September 1886, 1675 persons, of whom eight had been inoculated (in 1884, the method being then imperfect). This gives a mortality of about 1 per 1000 for the inoculated, and 1 per cent. for the uninoculated. It is remarkable that there has been no epidemic of yellow fever in Rio de Janeiro this year (a thing not known for the last thirty-five years). The microbe of yellow fever is called *Cryptococcus xanthogenicus*. Dr. Freire gets a culture liquid for inoculation, on the principles of M. Pasteur's methods, and he injects about one gramme of it subcutaneously.

EXPERIMENTS have been recently made by S. Leone (*Gazetta Chimica Italiana*) as to how organic substances in water are affected by development of bacteria. He used distilled water, to which a little gelatine was added. The organic nitrogen and carbon are changed by the organisms into inorganic compounds, chiefly carbonic acid, ammonia, nitrites, and nitrates. It appears that up to the fifteenth or sixteenth day the ammonia steadily increased, then it decreased till it was quite gone. Meanwhile, nitrous acid appeared ; it increased as the ammonia disappeared, and when this was gone, a formation of nitric acid began, at the cost of the nitrous acid, so that in thirty-five days the latter too was quite gone, and only nitric acid present. If a little gelatine was put in the water which had turned ammonia into nitrates, the reverse process began ; ammonia was formed again, and even directly added nitrate was changed into this. If no fresh gelatine was added, however, nitrites and nitrates were again produced. The author ascertained that the same organisms that in *presence* of organic substances formed ammonia, in *absence* of such effected nitrification.

PROFS. KRUSS AND NILSON, of Stockholm, have succeeded in preparing a double fluoride of potassium and the new element germanium, K_2GeF_6, isomorphous with the corresponding double fluoride of ammonium and silicon, thus proving most conclusively that this recently discovered element belongs to the silicon, titanium, zirconium, tin, and lead group of the periodic classification. The fluoride of germanium, GeF_4, which is not gaseous, but resembles zirconium fluoride, ZrF_4, was first prepared by dissolving the oxide, GeO_2, in hydrofluoric acid ; and the double fluoride separated in the gelatinous form on adding the calculated quantity of potassium fluoride. On filtering, however, the salt dried to a crystalline powder resembling potassium silicofluoride, but being more soluble than the latter, separated from solution in hot water in beautiful tabular crystals, and from a solution in cold water on evaporation over sulphuric acid in pyramid-capped prisms several millimetres long. Once more the value of Newlands' and Mendelejeff's generalization as an incentive to research is demonstrated, and confidence in its truth inspired, for Mendelejeff himself predicted that "ekasilicon will yield a double fluoride isomorphous with the double fluorides of silicon, titanium, zirconium, and tin, of greater solubility than that of silicon ; and the fluoride, like the fluorides of titanium, zirconium, and tin, will not be gaseous."

A NEW synthesis of uric acid, directly proving its constitution, has been effected by Prof. Horbaczewski (*Monatshefte für Chemie*, May 28, 1887). The reaction is very simple and consists in fusing together 1 part of trichlorlactamide, $CCl_3—CHOH—CO—NH_2$, with 10 parts of urea, $CO(NH_2)_2$, when 15 per cent. of uric acid together with ammonium chloride, hydrochloric acid, water, and a few decomposition products are obtained. By a long process of separation and purification the uric acid was obtained quite pure, in crystals exactly resembling those obtained from natural sources. This method of synthesis points to the extreme probability that the constitution assigned by Medicus to uric acid is correct, and shows that it is the di-ureide of acrylic acid. Probably no work has been watched with keener interest than the attempts which have been from time to time made to solve the problem of the constitution of this complex molecule, and it is a matter of great satisfaction to have our knowledge of a substance so widely occurring in animal secretions, and parent of so many derivatives, founded upon a method of synthesis so direct.

SUPERFICIAL tension in liquids being, like the magnetic state, an essentially molecular phenomenon, we might expect that it and phenomena depending on it would be modified by action of an intense magnetic field. Prof. Dufour lately proved such an effect by making mercury flow through a horizontal capillary tube placed between the poles of a strong electro-magnet. The liquid describes a parabola, the vein being continuous to a certain distance from the orifice, when it separates into drops. While the magnet acts the parabola is stretched, and the continuous part of the vein lengthens, indicating more rapid flow.

ATTENTION has been lately called by Herren Kerner and Wettstein, in the Vienna Academy, to two carnivorous plants found in Germany. One of these is the leadwort root (*Lathræa squamaria*) which has no chlorophyll, and passes for a parasite, as it fixes, with small nipples, on the roots of fruit-trees. The pale stems, appearing in shady moist places in spring, are covered thickly with scale-like leaves, each of which has its upper half rolled back on the back of the lower, leaving a hollow space between. Into this open by small holes from five to thirteen separate chambers, having on their surface numerous tufted hairs and hemispherical horns connected with the vascular bundles. Various small animals get into these chambers, and ere long disappear. From both hairs and horns threads of plasma stream out, when the animals come into contact with them, and lay hold of them. Though it is not exactly proved that the plant benefits by the animals it thus catches, this seems very likely from its general character. It is more remarkable that a plant containing chlorophyll, and existing independently, like *Bartsia alpina*, should have similar organs for capture of animals, and should feed on such, as the authors assert. The plant forms in autumn underground buds covered with scales, whose lateral borders are rolled outwards, making a hollow in which are organs quite similar to those in the leadwort root.

THE habits of the rainbow trout (*Salmo irideus*) in their fry stage are in some respects very different from those of other species of Salmonidæ. At the present time many thousands of them may be seen in the ponds belonging to the National Fish-Culture Association at Delaford Park, where they were hatched out in the spring from ova sent from California. Instead of moving about in groups or shoals, they isolate themselves from one another, and are to be found in every part of the pond instead of at certain spots or on shallows. Again, the rainbow trout fry are visible within half a foot of the surface of the water, while other varieties hide from view. They appear to be exceedingly voracious, and this may account for their capacity for rapid growth, which exceeds that of their congeners.

IN one of the Selborne Society Letters, issued the other day, the Rev. S. A. Preston, the founder and for many years the President of the Marlborough College Natural History Society, sets forth his ideas as to the best method of promoting the study of natural history in schools. He thinks (1) that each boy should have the elements of two or three branches of natural history put before him,—as a general rule, nothing more than the elements would be required; (2) that this should be done so as to make it as interesting to him as possible, so that he may look forward to his natural history lesson; (3) that if he "takes" to any particular subject, means should be at hand to enable him to go on with it; (4) that he should be encouraged to work out of school. Mr. Preston is of opinion that the appointment of "science masters" is not necessary for the attainment of these ends. "Among any body of masters now," he says, "there are sure to be some who are fond of some branch of natural history, and who can teach the elements of their subject (as far as is necessary for boys in general), and do it in a pleasing and interesting manner. At the end of a long afternoon's work at regular school subjects, the master should occupy the last half-hour or so (if the other lessons have been well said) with a discussion upon his special branch, showing specimens, encouraging questions, and making this part of his work as different as possible from the ordinary work. Boys will look forward to this time, and will work all the harder at their other work to get this 'talk,' if a good lesson is required before the natural history one. By the end of a term, with a little system, the elements of the subject may easily be learnt. The next term, masters should change forms for this half-hour, and the boys thus have some new subject put before them. In a few terms, therefore, a very fair general knowledge of natural history may be secured. If a boy showed any aptitude in any one branch, there would be a master at hand ready to help him and get him on."

MR. C. S. WILKINSON, the New South Wales Government Geologist, reporting upon the seams of coal pierced in the diamond-drill bore at Holt-Sutherland, near Sydney, says that in this bore a depth of 2307 feet from the surface, or 2175 feet below sea-level, has been attained. This is the deepest diamond-drill bore in Australia. The diameter of the bore to a depth of 500 feet is 3½ inches, and below that depth it is 3 inches. The strata passed through consist of Hawkesbury sandstones, 653 feet 6 inches; shales, sandstone, and conglomerates (the upper 314 feet consisting chiefly of chocolate-coloured shales), 1573 feet 3 inches; upper seam of coal, 4 feet 2 inches; shales, sandstone, and conglomerate, 65 feet; lower seam of coal, 5 feet 3 inches; black shaly sandstone, 5 feet 11 inches.

A HEAVY snowstorm is reported to have occurred on the Scheekoppe on June 11. On the Kapellenberg, between Hirschberg and Schönau, it snowed severely, and in the night the thermometer sank to 3°.

A TELEGRAM from Omsk to St. Petersburg of the 21st inst. states that there were several slight oscillations of the ground at Vernoé on that day. To the west of Karakoul the earthquake had been more violent than at the latter place; a lake in the neighbourhood had sunk 3 feet. Almost all the Government buildings at Vernoé are said to be destroyed.

TWO beaver colonies have just been discovered at Amlid, near Christiansand, Norway. On the bank of a river the beavers have made lodges of branches of trees, which are held together with clayey mud, the whole resting on logs of wood. The entrance, a hole, faces the river, but is below the surface of the water. Round the entrance there are numbers of aspen and birch trees, the bark of which has served as food for the animals. The beaver gnaws the tree about 2 feet from the root, and if it finds the bark to its taste, cuts the tree up in pieces from 2 to 3 feet in length, which the animal then drags or carries down to its house—proceedings which are fully demonstrated by the many "log-runs" in the woods along the river bank. Observers have also noticed another remarkable habit of this interesting animal, viz. that on arriving by the water-side with such a log of wood it will poise the piece on the back of its neck and swim with it right into the lodge, where the bark is gnawed off and stored away for winter use. This accomplished, it will shoot the log into the river. The largest trees the animals have dealt with in this manner are 11 inches in diameter. The colonies are situated far from human dwellings, where people only come in winter, during the timber-felling season.

AT the Ladies' *Soirée* at the Royal Society on June 8, much attention was attracted by the fine exhibit sent from the Royal Gardens, Kew. Great credit is due to the officials at Kew for the care with which the objects were selected and displayed. The following is a list of the flowering plants:—*Myrmecodia Beccari*, *Myrmecodia* sp. New Guinea, *Leea amabilis*, *Impatiens Hawkeri*, *Primula Reidii* and *cortusoides*, *Piper porphyrophyllum*, *Streptocarpus Dunnii* and *polyanthus*, *Coffea liberica*, *Tillandsia splendens* and *usneoides*, *Caraguata Zahnii*, *Cypripedium Stoneii*, *Dendrobium Dalhousieanum* and *transparens*, *Epidendrum vitellinum*, *Odontoglossum Hallii*, *Miltonia vexillaria*, *Sarracenia Patersoni*, *Palumbina candida*, *Areca monostachya*, *Licuala grandis*, *Verschaffeltia splendida*, *Caryota Blancoi*, *Cycas undulata*, *Hemitelia Smithii*, *Adiantum amabile*, *Acrostichum crinitum*, *Brainea insignis*, *Saccolabium curvifolium*. There were cut flowers of *Hæmanthus magnificus*, *Randia Stanleyana*, *Hexacentris mysorensis*, *Senecio macroglossa*, *Iris Susiana*, *Chamædorea elegantissima*, *Bougainvillea spectabilis*, *Napoleona imperialis*, *Cochliostema Jacobianum*, *Pandanus odoratissimus* (cone), *Musa coccinea*.

THE additions to the Zoological Society's Gardens during the past week include a Moustache Monkey (*Cercopithecus cephus* ♀) from West Africa, presented by Mr. Bernard Lawson; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. G. Choutte; two Lions (*Felis leo* ♂ ♀) from Kittywar, Guzerat, India, presented by Major J. Humphrey; two Striped Hyænas (*Hyæna striata*) from India, presented by the Bombay Natural History Society; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mrs. H. A. Warwood; an Australian Crane (*Grus australasiana*) from Australia, presented by Mrs. M. S. Richman; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mrs. Crabtree; two Edible Frogs (*Rana esculenta*), European, presented by Mr. H. A. Crossfield; three Green Turtle (*Chelone viridis*) from Ascension, presented by Capt. C. Theobald, R.N.; a European Pond Tortoise (*Emys europæa*) from Venice, presented by Mr. Alban Doran; an Alligator (*Alligator mississippiensis*) from Florida, presented by Mr. Hugh Bellas; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, five Common Dormice (*Muscardinus avellanarius*) British, deposited; a Little Egret (*Ardea garzetta*), a Buff-backed Egret (*Ardea russata*), European, a Horrid Rattlesnake (*Crotalus horridus*) from Brazil, purchased; a Yak (*Poëphagus grunniens*), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *JULY* 3–9.

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

At Greenwich on July 3.

Sun rises, 3h. 50m.; souths, 12h. 3m. 53·0s.; sets, 20h. 17m.; decl. on meridian, 22° 59′ N.: Sidereal Time at Sunset, 15h. 3m.

Moon (Full on July 5) rises, 18h. 22m.; souths, 22h. 48m.; sets, 3h. 11m.*; decl. on meridian, 19° 4′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury	6 11	13 52	21 33	18 12 N.
Venus	7 55	15 11	22 27	13 54 N.
Mars	2 30	10 49	19 8	23 46 N.
Jupiter	13 35	18 53	0 11*	8 56 S.
Saturn	4 57	12 59	21 1	21 25 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich).

July.	Star.	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image.
			h. m.	h. m.	° °
6	π Capricorni	5	21 3	near approach	149 —
6	B.A.C. 7053	5½	21 49	22 53	37 280
6	o Capricorni	5½	21 49	22 54	38 280
9	42 Aquarii	6	0 48	1 45	43 320

Variable Stars.

Star.	R.A.	Decl.		
	h. m.	° ′		h. m.
U Cephei	0 52·3	81 16 N.	July	7, 23 13 *m*
δ Libræ	14 54·9	8 4 S.	,,	9, 0 8 *m*
U Coronæ	15 13·6	32 4 N.	,,	9, 1 29 *m*
U Ophiuchi	17 10·8	1 20 N.	,,	6, 0 12 *m*
S Sagittarii	19 12·8	19 14 S.	,,	9, *M*
T Capricorni	21 15·8	15 38 S.	,,	9, *M*
δ Cephei	22 25·0	57 50 N.	,,	8, 1 0 *m*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES.

AT Monday's meeting of the Royal Geographical Society, Mr. J. T. Last gave a brief preliminary account of his recent explorations among the Namulli Hills, to the south-east of Lake Nyassa and along the River Rovuma. He found that, although the thermometer often falls below freezing-point, no snow exists on the Namulli Hills. At the same meeting, General Haig read an unusually interesting paper on a recent journey he made in the south-west corner of Arabia. He started from Hodeida, went inland to Sana'a, and south to Aden. He found himself in a region of mountains rising to over 10,000 feet, in many places terraced by the natives up to a height of 8000 feet. The scenery was often of the most magnificent and picturesque description, and the climate so comparatively temperate as to be suited for European settlement. The whole region of which this forms part, and indeed the entire southern portion of Arabia, including Hadramaut and Omân, is one that would richly repay serious exploration. General Haig made a journey of about fifty miles into the interior of Omân, and found that, while there was a rainfall of only 6 inches on the coast, at least 30 inches fell upon the hills of the interior.

SOME further steps have been taken in Australia for the prosecution of Antarctic exploration. The Antarctic Committee appointed by the Royal Society of Victoria and the Royal Geographical Society of Australia have memorialized the Premier of Victoria on the propriety of stimulating Antarctic research by the offer of bonuses. They recommend that a sum of £10,000 be placed on the Estimates for this purpose, and that tenders be solicited from shipowners for the performance of services in connexion with Antarctic exploration. It is stipulated that shipowners whose tenders are accepted shall provide, free of charge, cabin accommodation in each ship for two gentlemen, who will sail as the scientific staff; and a second cabin as instrument-room and office. The master of the ship must afford these gentlemen every facility for observing natural phenomena. The master will receive special bonuses for every hundred tons of oil from fish caught south of 60° S. The special services desired are as follows:—A flying survey of any coast-lines lying within the Antarctic Circle, and not laid down upon the Admiralty charts; the discovery of new waterways leading towards the South Pole, and of harbours suitable for wintering in. Opportunities must be afforded to the scientific staff to add to our knowledge of the meteorology, oceanography, terrestrial magnetism, natural history, and geology of the region. Special bonuses will be given for passing 70° S., and also for establishing on shore a temporary observing camp. Two ships are wanted, and both must be in Port Philip Bay and ready to start on October 15. The Premier of Victoria, we are glad to say, has promised to place £10,000 on the next Estimates for these purposes, on condition that the other colonies will join in the enterprise; this they no doubt will do.

THE Russian Government has decided to establish Chairs of Geography in the Universities of the empire. The first appointment will be to the University of St. Petersburg in the autumn of the present year.

MR. MCCARTHY, the Government Surveyor of Siam, has just returned to this country, with a very fine set of maps of that country, embodying the results of seven years' survey work. These he is working out at the Royal Geographical Society.

MR. W. J. STEAINS has just returned from Central Brazil, where he has spent a considerable time among the Botocudos, a savage people, concerning whom our information is exceedingly scanty. Mr. Steain's has collected much information concerning these people, and brought home some two hundred sketches, which he will probably publish soon in some form.

ONE of the public lectures at the Manchester Meeting of the British Association will be by Sir Francis De Winton, late Governor of the Congo Free State. Sir Francis, we believe, will illustrate his lecture with a series of maps (perhaps thrown on the screen) showing the progress of our knowledge of Central Africa from the time of Ptolemy down to the present day.

DISCOVERY OF FOSSIL REMAINS OF AN ARCTIC FLORA IN CENTRAL SWEDEN.

FOR the first time fossil remains of an Arctic flora have been discovered in the great stretch of land between Scania and Norrland. The discovery was made in a part where it was least expected, viz. just north of the town of Vadstena, close to the shore of the lake Wettern. The soil in the vicinity of Vadstena greatly resembles that of South-Western Scania, being mostly formed of moraine clay or clayey moraine sand, whilst marine formations appear to be absent in the former place; they are, however, found further to the north-east, but I have as yet been unable to ascertain the limits of the two districts. Within the moraine clay are found here and there little cavities or depressions, occupied by peat bogs or alluvial formations. Close to the shore of the lake Wettern, barely a third of a kilometre north-east of Vadstena, such a depression occurs, occupied by a peat bog. This peat bog continues to the north-east beyond the depression, a little way up the rising ground, caused by the existence here of some strong wells, around which in remote times considerable quantities of calcareous tufa have formed. My attention was drawn to this locality by Dr. J. Jönsson, who had noticed the tufa under some work effected for the Geological Survey of Sweden, but not having closely examined the fossil remains of plants in the same, he was only able to inform me that he had found mosses therein.

On examining the collection of specimens of the tufa obtained, I found at the back of one some well-preserved leaves of *Dryas octopetala*, L., other fossil remains in the same fragment, besides mosses, being branches of *Empetrum* and leaves of *Vaccinium uliginosum*, L. In consequence of this discovery, I decided to visit the spot myself, partly in the hope of discovering some more specimens of *Dryas*, and partly in order to study the adjacent layers of earth and the strata containing the fossil plants. But although I spent a whole day in examining loose blocks and the accessible parts of the strata I did not succeed in finding any more leaves of *Dryas*.

The calcareous tufa is, as I have stated, deposited on a declivity and around a well, and the latter, whose flow is rather strong, is now exposed through the removal of the peat (a couple of feet in thickness) which covered it, along with the tufa immediately round the well. The latter appears to have rested immediately on clayey moraine *débris* or moraine clay (bottom moraine), whilst nearest the well the lower layers are sinter-formed without distinct remains of plants, though probably containing such pine needles and mosses as are found in the upper layers. The mosses are in the upper part of the tufa in certain places common, and form sometimes separate layers consisting solely of such. The composition of the bed seemed to be as follows:—Lowest, the lime had formed round growing grass or Juncaceæ, the leaves of which are indicated by more or less perpendicular holes. Next above this appears a more distinctly stratified tufa, containing leaves and exterior bark of the pine, but, judging from the fragments thrown up in the vicinity, the layer containing *Betula nana* should be placed between these two. As a proof of such a layer are the mosses, leaves of *Vaccinium uliginosum*, *Empetrum*, and even needles of pine, although more seldom than in the true pine layer. From the layer containing remains of dwarf-birch the piece of tufa with the *Dryas* leaves was undoubtedly obtained. Some samples of this tufa show a relatively rapid precipitation, the needles and pieces of bark themselves being sometimes found intact on the cleaving of the tufa. In this layer are also found remains of a species of broad-bladed grass, and Herr Carlson has further found in it the imprint of a feather. Uppermost, at all events in certain spots, mosses only are found. The calcareous tufa, the greatest thickness of which is hardly more than 3 feet, is in turn covered with peat.

In the tufa are sometimes found, in layers, thin bands of remains of plants, chiefly of grasses and mosses, the vegetable substance of which is still preserved. In such a layer even a leaf of *Betula nana* was found. Besides the above-mentioned remains of plants may be mentioned leaves of at least three different kinds of Salices, one reminding of *S. cinerea*, one of *S. repens*, and one which most certainly cannot be referred to any of the varieties now found in Southern Sweden. In addition to those of *Betula nana*, imperfect leaves of a large birch-tree, probably *B. odorata*, have been found, and also a perfect leaf of one apparently corresponding with *B. intermedia*, although there is some probability that it may be a smaller leaf of *B. odorata*, it being generally impossible to define leaves varying so much as those of *Betula* and *Salix* from a single imprint.

Of the species just named, two at all events, viz. *Betula nana* and *Dryas octopetala*, are extinct near Vadstena. It is also probable that one of the varieties of *Salix* is now foreign to these parts. *Betula nana*, however, is still found in certain parts of Östergötland, but the nearest spot in which *Dryas* grows is in the mountains around the valley Herjedalen, about 4° to the north-west of the lake Wettern, and we may safely assume that the presence of these two plants in the same locality clearly indicates that at the time of the deposition of the older layers of calcareous tufa the climate was much colder than that now prevailing there. For my own part, I am even disposed to consider this discovery of fossil *Dryas* near Wettern as a proof of a purely Arctic flora having prevailed in these parts at an age older than that represented by the calcareous tufa; studies of the same in the province of Jemtland in my opinion indicating that a true Arctic climate is not favourable to the development of calcareous tufa, this mineral being first deposited after the climate has become milder. In Jemtland we certainly find Arctic plants in the tufa, but generally together with remains of pine, and they must therefore be considered as the last remnants of an Arctic flora, which already then was in course of being supplanted by the pine and accompanying species. Its greatest significance lies, not only in the proof of an Arctic flora once having flourished in these parts, but also in the circumstance that it proves that an Arctic flora could exist at such a low elevation.

It will further appear from the above exposition that the Arctic flora in this locality was followed by a pine vegetation, the process thus entirely corresponding with what took place in Scania and Norrland. Information from other localities in these parts is, however, required before we can arrive at general conclusions.

Finally, it may not be out of place here briefly to refer to a question which to some extent may be considered to be affected by this discovery. In a paper read in 1860 before the Academy by Prof. Sven Lovén, "On some Crustacea found in the lakes Wettern and Wenern," the author pointed out that, as regards Wettern, this lake sheltered a fauna belonging to deeper waters, of originally marine and at the same time Arctic character. This fauna Prof. Lovén considered to be a relic from the time when Wettern, by way of the Baltic and Lake Ladoga, was connected with the Arctic Ocean. He said:— "Some few favoured species, those which in a higher degree than others were able to adapt themselves to the new medium, and which already in their former habitat, the less saline Arctic Ocean, had accustomed themselves to live for instance where melting glaciers diluted the sea-water, or at the mouth of rivers, would in one or another of the great lakes thrive longer than others, and finally be the only ones surviving. Such a lake is Wettern." It should be pointed out that the discovery of the fossil *Dryas* leaves on the shore of the lake Wettern is of considerable significance in view of the opinion thus expressed by Prof. Lovén. For the calcareous tufa referred to here having been deposited *since* the sea had already receded from these parts, and this tufa nevertheless containing Arctic plants, we may conclude that the lake Wettern became separated from the sea whilst the climate was still Arctic.

A. G. NATHORST.

GEOLOGICAL STRUCTURE OF FINISTÈRE.

THIS article is founded upon the "Aperçu sur la constitution géologique du Finistère," prepared for a recent excursion of the Geological Society of France by Dr. Charles Barrois, of Lille.

Since the three great promontories of South Wales, Devon and Cornwall, and Brittany, are sharers in no small degree of a common geological history, English geologists can hardly fail to take an interest in the structure of the western extremity of Brittany. Dr. Barrois is very well known to many of us, and the fact that for some time past he has been engaged on the geological survey of Brittany renders his observations all the more valuable. From time to time he has furnished the annals of the Société Geologique du Nord with some of the results of his observations in that country. Of these we may mention "Le granite de Rostrenan (Côtes-du-Nord), ses apophyses et ses contacts," "Mémoire sur les schists métamorphiques de l'île de Groix (Morbihan)," "Mémoire sur les grès métamorphiques du massif granitique du Guéméné (Morbihan)," "Note sur la structure stratigraphique des Montagnes de Menez (Côtes-du-Nord)," and "Légende de la feuille de Châteaulin (Finistère)."

The department of Finistère is traversed from east to west by two parallel chains—on the south the Black Mountains, on the north the Mountains of Arrée. Between the first-named chain and the Atlantic lies the southern plateau of Brittany, whilst the northern plateau is situated between the Mountains of Arrée and the English Channel. Both plateaux are formed by Archæan (*primitifs*) and Cambrian rocks more or less injected by granite. The basin included between the two ranges presents a series of beds extending from the Silurian to the Carboniferous in parallel folds, and is evidently one of the most important physical features in the north-west of France.

The stratified rocks of the region present the following succession:—

Carboniferous.

Schists and Conglomerates of the Coal-Measures.
Schists and Sandstones of Châteaulin.
Porphyritic Tuffs.
Conglomerates and Porphyritic Tuffs.

Devonian.

Nodular Schists of Porsgruen.
Schists and Limestones of Néhou.
White Grit of Landévennec.
Schists and Quartzites of Plougastel.
Limestone of Rosan with *S. looiensis.*

Silurian.

Nodular Schists with *C. interrupta.*
Bituminous Schists with Graptolites.
White Sandstones.
Slates of Angers.
"Grès Armoricain."
Conglomerates and Red Schists of La Chèvre.

Cambrian.

Schists and Conglomerates of Gourin.
"Phyllades" of Douarnenez.

Archæan.

Schists of Groix.
Mica Schists of Audierne.
Granitic Gneisses of Pont-Scorff.

Archæan.—The most ancient group of rocks in Finistère consists of certain granitic gneisses and mica schists. The gneisses are devoid of white mica, consisting mainly of white and rose feldspar in large grains, with abundance of black mica, in foliations, sometimes replaced by hornblende in fragments, with granitoid and secondary quartz. These gneisses alternate with interstratified beds of mica schists and amphibolites, and pass into gneissic granites which penetrate them after the manner of an eruptive rock.

The injection of this *gneissic granite* may be explained in three different ways: (1) either it is contemporary with the gneiss and the mica schists, or (2) it may date from a later epoch, or (3) lastly, it may proceed directly from the gneisses by means of local recrystallisations under the action of a powerful general metamorphism. If we accept the first of these hypotheses, says Dr. Barrois, the conditions remind us somewhat of the *Dimetian* proposed by Dr. Hicks for Wales. It is evident, however, that he is more disposed to favour either of the other hypotheses.

Certain mica schists are largely developed in the southern plateau; they alternate with subordinate beds of fine-grained gneiss, amphibolites, chlorite schists, micaceous schists, and interstratified masses of diorites and "gneissites" of eruptive origin. These accessory rocks form, together with the mica schists into which they are injected, long parallel bands from one end to the other of the southern plateau. The "gneissites" include a complete assemblage of acid rocks, remarkable for their gneissic, ribboned, and glandular structure, rich in white mica, and in secondary feldspar, with "granulitic" quartz in elongated grains, in rounded drops, and in thin flakes. These include the rothe-gneiss, augen-gneiss, flaser-gneiss, stengel-gneiss, hälleflintas, and leptynites of the German geologists; as also the rhyolitic felsites, volcanic breccias, hälleflintas, and felsitic tuffs of the English geologists.

Is the injection of the "gneissites" contemporary with the mica schists, or should it be referred to a subsequent epoch? If we accept the first of these hypotheses, the stage so termed may be said to ally itself by its lithological characters to the *Arvonian* of Dr. Hicks. It would seem, however, that in making the (geological) sheets of Lorient and Chateaulin, Dr. Barrois and his coadjutors have adopted another view, by referring the characters of the "gneissites" or "granulites feuilletées" to their consolidation in special "encaissements" under suitable mechanical conditions of depth and pressure, and at an epoch different, but as yet undetermined, from that of the massive granulite of Pontivy.

The schists of Groix constitute a stage of micaceous schists, of chloritic and chloritoid schists, of carbonaceous schists, and of mica schists, especially remarkable for the abundance of the heavy minerals which they contain (staurolite, garnet, magnetite, &c.). The carbonaceous or graphitic schists sometimes referred to the Cambrian would appear to form the base of this stage. The boundary between it and the Cambrian is admitted to be obscure. If this stage, says Dr. Barrois, corresponds to the *Pebidian* of Wales, it is distinguished by its poverty in interstratified basic rocks, which are always of limited extent in Brittany.

Cambrian.—How far these greenish-gray satiny schists, with their beds of quartzite and veins of quartz, correspond to any British Cambrian beds, the author admits is uncertain. Moreover, we would observe that there is no mention here of any bed of conglomerate at the base of the Cambrian. Hence the evidence as to the antiquity of the presumably pre-Cambrian rocks fails in this important particular. The author estimates this stage (Phyllades of Douarnenez) at over 3000 metres. Above these are beds of schist and conglomerate in regular interstratification. The conglomerates are formed of little pebbles of quartz with about 1 per cent. of other stones. They are distinguished from the Silurian conglomerates by the smallness of their component parts, and by their inferior hardness. The equivalents of these beds in the north of the department are fossiliferous, and correspond to the *Paradoxides* beds of la Vega in the Asturias,[1] and to stage C of Barrande. Here then we have our first palæontological horizon in Brittany which would seem to be Menevian.

Silurian.—The lowest sta[illegible] thus classified consists of red schists, variegated quartzites, and beds of quartzose conglomerate. This is succeeded by the famous "Grès Armoricain," which forms the most salient feature of Menez-Hom and the Black Mountains. It is characterised by *Scolithes*, *Bilobites*, *Linguleæ*, &c., and is the most constant of the fossiliferous beds of Finistère. Barrande's stage D is represented by the slates of Angers with *Calymene tristani*, &c. The three horizons of the third Silurian fauna are with difficulty traced on the north of the Black Mountains.

Devonian.—From a geognostic point of view the schists and quartzites of Plougastel, over 1000 metres in thickness, constitute the most important stage of this system, being largely developed in the roadstead of Brest and forming the northern crest of the Black Mountains. *Homalonotus* sp., *Rhynchonella puilloni*, and *Grammysia davidsoni*, are amongst the few fossils. Above these come beds recalling the Taunusian, Coblenzian, and Eifelian, for the most part fairly fossiliferous. As no higher ones are mentioned, we may presume that the Middle and Upper Devonian are absent.

[1] See *Geological Magazine*, 1883, p. 274.

Carboniferous.—The physical history of Brittany during this period was one of oscillation between terrestrial and marine conditions; it was a period of extensive eruptions and of great earth-movements. Hence a considerable portion of the sediments, especially towards the base, are of volcanic origin. The mass of the formation is comprised in what Dr. Barrois calls the "schists of Châteaulin," an alternation of schists, slates, and sandstones with *Spirifer striatus*, *Strophomena rhomboidalis*, *Phillipsia derbyensis*, and *Productus semireticulatus*: they also contain poor impressions of plants. In some respects this description reminds us of the Culm of Devonshire. This group rests unconformably on the various Devonian beds. The actual Coal-Measures form three small and distinct basins in Finistère of little economic value.

It is interesting to note that the volcanic phenomena in this region are referred to the Carboniferous rather than to the Devonian epoch, and this serves to recall the controversy as to the precise geological age of the rocks in the Brent Tor district—a doubt which is applicable to a large area of Palæozoic rocks lying to the north-west of Dartmoor. Since, in Brittany, the Carboniferous rocks are unconformable to the Devonian, whilst the intermediate deposits consist in many places of porphyritic tuffs, it is evident that the chief deposit of ashes and other volcanic material represent formations intermediate in respect of time. Why may they not in part be Middle and Upper Devonian? To the Carboniferous period also are referred the porphyroid granites of Rostrenan and other places, and the numerous veins of quartz porphyry, which are so apt to follow the synclinal folds of the sedimentary rocks, the prevailing direction being a little to the north of east. The eruptions, according to Dr. Barrois, must have commenced after the Devonian, and continued during the whole of the Lower Carboniferous. The most important development of quartz diorite, which follows the southern foot of the Black Mountains, he regards as posterior to the Devonian and anterior to the Carboniferous.

Lastly, Dr. Barrois speculates on the earth-movements that have helped to fashion the country of Finistère, which may be said to possess a radiate structure in consequence of the numerous flexures undergone by the rocks; the general orientation is east to west, but with a tendency to converge towards west. These directions correspond to axes of a complete series of synclinals and anticlinals. The eruptive rocks of the region have been affected at the same time as the sedimentary rocks, whose foldings they have followed; they made their appearance chiefly at two epochs, during the Archæan (*terrain primitif*) and during the Carboniferous, thus affording two periods of maximum eruptive force. The principal periods of flexing appear to have been five in number, and correspond in the main to the breaks in the great systems already detailed. The fifth and greatest flexure took place after the Upper Coal-Measures: it has left its mark on all the formations, and since that period Finistère has been in a condition of *terra firma*. W. H. H.

TEMPERATURE IN RELATION TO FISH.

THE influence of temperature exerts itself to such a marked degree upon the habits, food, reproduction, and migration of fish, that observations upon the subject are essential in determining the relations of certain forms to their surroundings. The National Fish-Culture Association have for some time past made investigations into the temperature of the ocean, not only at the surface, but also at the bottom, and the Council will shortly publish the results. In order to ascertain its effect upon fish maintained under artificial conditions, Mr. W. August Carter, of that body, has compiled the following statistics, showing the influence of temperature upon fish at the late South Kensington Aquarium, where the average depth of the tanks was 4½ feet. The statistics are derived from observations made daily during a period of three years by noting the temperature of the water in the tanks, and the death-rate prevalent at certain seasons of the year. By observing the degrees of temperature at which certain fish succumbed from time to time, Mr. Carter has drawn an average, showing the temperature adapted to various fish, and their capacity, in some instances, for withstanding extremes of heat and cold.

It must be borne in mind that the temperatures recorded are applicable only to fish in confinement, and living therefore under unnatural conditions. The temperature registered on the death of the fish named exceeded the highest and lowest degrees given below, which are, as already stated, intended to indicate the temperature of water in which they can be maintained in aquaria.

Marine Fish.

Species.	Temp. ° Fahr. Highest	Temp. ° Fahr. Lowest	Remarks.
Gurnard	62	49	Highly sensitive
Wrasse	55	50	,, ,,
Dogfish	71	45	Occasionally exist when in 38°
Mullet	70	35	Very hardy
Eels (Conger) ...	70	40	Occasionally at 30°
Bullhead	62	49	Thrives best at 55°
Skate...	70	45	
Sole	62	51	Thrives best at 56°
Flounder	70	35	
Plaice	70	35	
Bream	65	45	Thrives best at 58°
Bass	70	35	
Cod	70	35	Thrives best at 55°
Crayfish	60	45	Cannot exist in extremes
Blennie	58	43	
Fresh-water Fish.			
Trout...	71	34	
Perch...	65	43	
Dace	60	44	Occasionally at 32°
Tench (Common)	65	45	
,, (Golden)..	68	45	
Roach	60	50	
Catfish	70	43	Occasionally at 38°
Eels	70	35	
Carp	70	35	
Gudgeon	55	43	
Pike	70	36	
Minnow	55	46	
Chub...	50	40	

It will thus be seen that the dogfish, mullet, conger, skate, flounder, bass, cod, trout, catfish, pike, and carp are extremely hardy, and can exist in both a high and low temperature, ranging from 34° to 71°. On the other hand, the gurnard, wrasse, bullhead, sole, bream, crayfish, blennie, perch, dace, tench, minnow, chub, roach, and gudgeon show themselves sensitive to extremes of temperature.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 16.—"On the Tubercular Swellings on the Roots of *Vicia Faba.*" By H. Marshall Ward, Fellow of Christ's College, Cambridge, Professor of Botany in the Forestry School, Royal Indian College, Cooper's Hill.

In this paper the author gives a detailed account of his investigations, of which the following is a short abstract.

The curious tubercle-like swellings on the roots of *Vicia* and other Leguminosæ have long been a puzzle to botanists and agriculturists. They have even been described as normal structures by some observers. The general opinion, however, has been that they are not so. Erikssen and Woronin at one time thought they contained Bacteria; Kny and others ascribed them to a Myxomycete; Frank and others had also observed certain extremely minute hyphæ in their tissues; but no one had been able to discover the connexion between the tubercles and a fungus.

By special methods of culture and observations extending over some time, Prof. Marshall Ward has discovered that the tubercles of *Vicia Faba* contain a fungus of a very definite kind, and he exhibited preparations showing the structure of the tubercles and fungus, and the entrance of the infecting hypha into the root-hairs of the plant: this infecting hypha passes down the root-hair and across the cortex, and then breaks up into finer hyphæ, from the ends of which are budded extremely minute germ-like bodies, which Woronin mistook for Bacteria. They are not Bacteria, however, but present more resemblance to the buds discovered by Brefeld in the *Ustilagineæ.*

The author has succeeded in artificially infecting the roots of beans with the fungus, and finds that the minute infecting spores are to be met with in all kinds of soil, so that it is a matter of some difficulty to obtain roots which are not attacked by the fungus. This can be done by burning the soil, and by means of pure water-cultures.

The affinities of the fungus are with the *Ustilagineæ*, and the case is a very remarkable instance of symbiosis.

"On the Structure of the Mucilage Cells of *Blechnum occidentale,* L., and *Osmunda regalis,* L." By Tokutaro Ito, F.L.S., and Walter Gardiner, M.A. Communicated by Prof. M. Foster, Sec. R.S.

The growing point of many ferns is found to be covered with a slimy mucilage, which arises from hairs situated on the paleæ and the leaves; this mucilaginous secretion serves a most important physiological function, in that it readily takes up and retains water, and thus keeps the young bud moist, and at the same time it prevents excessive transpiration. The authors investigated two cases of mucilaginous secretion, viz. *Blechnum occidentale*, L., and *Osmunda regalis*, L. They find that the mucilage arises from the protoplasm only, and not from the cell-wall, and that the whole process is distinctly intraprotoplasmic. They point out that the structure of mature mucilaginous gland is wonderfully like that of certain secretory animal cells recently investigated by physiologists; and they find that in the glandular cells of the ferns mucilage is secreted in the form of drops, and that each drop is further differentiated with a ground substance (gum mucilage), in which are embedded numerous spherical droplets (gum).

The secretion commences by the breaking down of a portion of the innermost layers of the endoplasm of a number of contiguous but isolated areas, and the result of these catabolic changes in the protoplasm is the formation of small but rapidly-growing mucilage-drops. The first formation takes place just beneath the free surface, equally around the whole cell-cavity, and the phenomenon steadily continues from within outwards, producing new drops basipetally, until the whole of the endoplasm has taken part in the process. The cell is now full of isolated drops, each inclosed by a portion of the delicate protoplasmic framework which still remains. A remarkable sequence of changes occurs in the drops themselves. At their first formation they are watery and by no means well defined; they shortly become denser, and then in the drops themselves a delicate reticulation may be observed, which gives way to the appearance of numerous minute and brightly shining droplets, all separate and distinct. The result of their observations makes the authors disposed to believe that during secretion the protoplasm gives rise to a gummy mucilage, and the latter undergoes further differentiation into a ground substance, which still retains its mucilaginous character, and into a gummy substance which is present as a number of isolated spherical droplets. Excretion takes place by the rupture of the cell-wall, all that remains in the cell being a layer of endoplasm with the disintegrated nucleus.

In the case of animal glands, *e.g.* serous and mucous salivary glands, the state of active secretion is followed by a resting-period, during which the protoplasm grows, forms new hyaline substance, and this again produces new granules. The authors believe that a series of changes essentially similar in character occur in plant-cells also. Usually speaking, plant-cells are incapable of such active and repeated secretion, and in many cases, *e.g. Blechnum* and *Osmunda,* the secretion-changes occur in the cell once and for all, and then the cell dies; in other instances, however, *e.g.* the glands of *Dionæa*, it appears exceedingly probable that the phenomena which accompany the repeated secretion are quite similar to those which happen in so many animal cells. They believe that in their main features the phenomena attending the formation of the secretion are very wide-spread, and limited neither to the ferns nor to the particular case of the secretion of mucilage.

Royal Meteorological Society, June 15.—Mr. W. Ellis, President, in the chair.—The following papers were read:—Amount and distribution of monsoon rainfall in Ceylon generally, with remarks upon the rainfall in Dimbula, by Mr. F. J. Waring. The principal feature in Ceylon as determining both the amount and distribution of rainfall is a group of mountains situate in the south central portion of the island, equidistant from its east, west, and southern shores. The south-west and north-east monsoons in Ceylon may be said respectively to blow steadily from May to August inclusive, and from November to February inclusive. In March and April, and in September and October, the weather is more or less unsettled, and no regular monsoon or direction of the air current is usually experienced. After giving details of the rainfall at twenty-five stations, the author concludes by remarking upon (1) the effect of the mountain zone in determining the amount and distribution of the rainfall; (2) the apparent gradual veering of the rain-bearing currents of air as each monsoon progresses; (3) the relative insignificance of the south-west monsoon as compared with the north-east monsoon in inducing rainfall; (4) the cause of the large general rainfall of the north-east monsoon throughout the island generally as compared with that of the south-west monsoon; and (5) the influence of the gaps in the external ring of the mountain zone, and of the central as well as the other ridges in it, in determining the amount of rainfall within the zone and in the neighbouring districts outside it.—Note on a display of globular lightning at Ringstead Bay, Dorset, on August 17, 1876, by Mr. H. S. Eaton. Between 4 and 5 p.m. two ladies who were out on the cliff saw surrounding them on all sides, and extending from a few inches above the surface to 2 or 3 feet overhead, numerous globes of light, the size of billiard-balls, which were moving independently and vertically up and down, sometimes within a few inches of the observers, but always eluding the grasp; now gliding slowly upwards 2 or 3 feet, and as slowly falling again, resembling in their movements soap-bubbles floating in the air. The balls were all aglow, but not dazzling, with a soft superb iridescence, rich and warm of hue, and each of variable tints, their charming colours heightening the extreme beauty of the scene. The subdued magnificence of this fascinating spectacle is described as baffling description. Their numbers were continually fluctuating; at one time thousands of them enveloped the observers, and a few minutes afterwards the numbers would dwindle to perhaps as few as twenty, but soon they would be swarming again as numerous as ever. Not the slightest noise accompanied this display.—Ball lightning seen during a thunderstorm on July 11, 1874, by Dr. J. W. Tripe. During this thunderstorm the author saw a ball of fire, of a pale yellow colour, rise from behind some houses, at first slowly, apparently about as fast as a cricket-ball thrown into the air, then rapidly increasing its rate of motion until it reached an elevation of about 30°, when it started off so rapidly as to form a continuous line of light, proceeding first east, then west, rising all the time. After describing several zigzags, it disappeared in a large black cloud to the west, from which flashes of lightning had come. In about three minutes another ball ascended, and in about five minutes afterwards a third, both behaving as the first, and disappearing in the same cloud.—Appearance of air-bubbles at Remenham, Berkshire, January 1871, by the Rev. A. Bonney. Between 11 and 12 a.m. a group of air-bubbles, of the shape and apparent size of the coloured india-rubber balls that are carried about the streets, were seen to rise from the centre of a level space of snow within view of the house. The bubbles rose to a considerable height, and then began to move up and down within a limited area, and at equal distances from each other, some ascending, others descending. These lasted about two minutes, at the end of which they were borne away by a current of air towards the east, and disappeared. Another group rose from the same spot, to the same height, with precisely the same movements, and disappeared in the same direction, after the same manner.—Mr. H. C. Russell, F.R.S., of Sydney, described a fall of red rain which occurred in New South Wales, and exhibited, under the microscope, specimens of the deposit collected in the rain-gauges.

Entomological Society, June 1.—Dr. David Sharp, President, in the chair.—Mr. Meyrick read two papers, on Pyralidian from Australia and the South Pacific, and descriptions of some exotic Micro-Lepidoptera. In these papers about sixty new species were described. A discussion ensued, in which Dr. Sharp, Mr. Stainton, Mr. McLachlan, and others took part. Mr. Meyrick stated that, as far as the Pyralidina were concerned, Australia could not be regarded as a separate region, for a large number were not endemic, but appeared to have been introduced from the Malay Archipelago. The method of this immigration seemed doubtful. Mr. Meyrick was of opinion that the insects flew very long distances, and effected a settlement through their food-plants being widely distributed and common. He instanced the undoubted immigration of certain Australian species into New Zealand, a distance of 1200 miles. Mr. Stainton adduced the instance of *Margarodes unionalis*, which is a South European insect, feeding on the olive, yet is occasionally found in Britain. —Mr. Meyrick also made some observations on the distribution of the insect fauna in the various regions of Australia: he said that it appeared to be more or less different in certain defined portions of the continent, which might be roughly regarded as oases in the midst of desert districts: all his observations, however, had tended to upset Mr. Wallace's theory that Eastern and Western Australia were originally separated, as the gradations in the insect fauna from east to west were quite gradual; in Western Australia the Tineina were the only group well represented by peculiar endemic forms.—Mr. Pascoe read a paper on the genus *Byrsops*, a genus of Curculionidæ.—The President announced that Lord Walsingham's collection of Lepidoptera and larvæ, recently presented to the nation, would be exhibited in the Hall at the Natural History Museum, South Kensington, until the end of June.

PARIS.

Academy of Sciences, June 20.—M. Janssen in the chair. —On the analytic theory of heat, by M. H. Poincaré. An attempt is here made to determine more rigorously than has hitherto been possible the principles from which are deduced the general laws of the analytical theory of heat in the case of any solid body whatever.—On the employment of crushers ("*manomètres à écrasement*") in measuring the pressures developed by explosive substances, by MM. Sarrau and Vieille. Continuing their studies on this subject, the authors here propose by means of the crusher to determine more especially the maximum pressure produced by an explosive under given conditions.—Fresh materials bearing on the relations which exist between the chemical and mechanical work of the muscular tissue, by M. A. Chauveau, with the assistance of M. Kaufmann. In continuation of previous papers, the author here deals with the nutritive and respiratory activity of the muscles which act physiologically without producing any mechanical work.—On collisions at sea, by M. Jurien de la Gravière. In connexion with the increasing number of disasters caused by preventable collisions, attention is directed to the practical measures recently proposed at various conferences by M. Riondel. Of these the most important are: (1) that all steamers be required to follow one outward and another homeward route, in order to divide the present single stream of traffic into two parallel streams; (2) that a maximum velocity be determined for vessels navigating narrow straits in foggy weather; (3) that the lighting of the high seas be rendered more powerful, and brought more into harmony with present rates of speed; (4) that international maritime tribunals be established in order to adjudicate between vessels of different nationalities. The latter proposition has already been approved by the United States, and several Governments have consented to take part in the future International Conference to which the whole question must be referred.—Observations on the Grazac meteorite, by MM. Daubrée and Stanislas Meunier. This meteorite, which fell two years ago, and to which M. Caravin-Cachin first drew attention, is of a new carbon type, somewhat analogous to those of Orgueil and of the Cape, but distinguished from them by its general appearance and chemical properties. Its breakage is granular, and in many respects it resembles certain varieties of the oxides of manganese and copper, and the bituminous cinnabar of Idria; density 4·16. This new specimen is all the more remarkable that it belongs to the class of rare and interesting meteorites which in their resemblance to our combustible minerals have suggested indications of biological phenomena beyond the globe.—On the molecular specific heats of gaseous bodies, by M. H. Le Chatelier. Since Dulong and Petit's discovery of the law of specific heats for solid bodies, numerous attempts have been made to generalize this law, and to extend it to the gases; but the experimental researches of Regnault have shown that at the ordinary temperature there exists no equivalence either between the molecular heats or the atomic heats of the gases. The experiments here described, on the combustion of gaseous mixtures, lead to the same conclusion for high temperatures.—On the calorific conductibility of bismuth in a magnetic field, and on the deviation of the isothermal lines, by M. Leduc. The discovery of the great increase in the electric resistance of bismuth, when introduced into a powerful magnetic field, has led the author to suppose that this field produces in the structure of the metal a modification, one of the effects of which is the deviation of the equipotential lines. It also occurred to him that this modification of structure should produce on a calorific flux the same alterations as on an electric current, and the experiments here described have fully confirmed these anticipations.—Application of the electrometer to the study of chemical reactions, by M. E. Bouty. In the author's last communication the problem was resolved in principle regarding the application of the electrometer to the study of chemical reactions. Here the subject is illustrated by the example of sulphuric acid and the sulphate of potassa.—On a new regulator of electric light, by M. Létang. The object of this apparatus is to obtain a distinct regulating control by means of a simple contrivance independent of any complicated machinery. The means employed to arrive at this result are based on the employment of a mechanism analogous to that of an ordinary system of electric chimes.—On the manganites of potassa, by M. G. Rousseau. The formation has already been described of a manganite of potassa by calcination of the permanganate at 240° C. But this method is useless for studying the variations of the molecular state of manganous acid combined with potassa under the action of a progressively increasing temperature. Hence the author has had recourse to the dissociation of the manganate of potassa in presence of an alkaline dissolvent.

BERLIN.

Physical Society, June 10.—Prof. Du Bois-Reymond, President, in the chair.—In connexion with his previous communications on the determination of the wave-length of light by the weight of a cube of quartz, Dr. Sommer spoke on the methods of determining the specific weight of bodies, with special reference to the method by weighing them in water. After having discussed the earlier methods and experiments of Marck and Lépiney, he gave an account of the methods he had himself employed in order to do away with the influence which the capillary forces at the surface of the water exert on the wire by which the solid is suspended. He surrounds the wire at the point where it enters the water with a glass tube 5 mm. in width, in which is placed one drop of a mixture of equal parts of olive-oil and benzene. From the lower end of the wire in the distilled water he hangs a tiny tray on which two cubes of quartz are placed. Using a wire 0·1 mm. in diameter, which he finds gives a result as accurate as weighing in air, he determines the weight of these quartz cubes in water, then pushes one of the cubes off the tray by means of a platinum wire which had been previously submerged, and weighs again. He then pushes the second cube off the tray and weighs a third time. These three weighings, taken in conjunction with the weight of the tray and cubes in air, yield an exactitude which up to the present time has either not been attained at all by hydrostatic methods or only by a laborious and roundabout process. The exactness of this method of determining the specific weight of quartz cubes surpasses that obtained by the use of a piknometer.—The President gave an account of a communication which had been made by Siemens at the last meeting of the Akademie der Wissenschaft. A steel tube 10 cm. long, with perfectly smooth external and internal surfaces and extremely uniform bore, and whose walls are apparently of perfectly equal thickness at all points, was prepared by the following method, patented by Männermann in Bemscheid. Two rollers, slightly conical towards their lower ends, are made to rotate in the same direction near each other; a red-hot cylinder of steel is then brought between these cylinders and is at once seized by the rotating cones and is driven upwards. But the mass of steel does not emerge at the top as a solid, but in the form of the hollow steel tube which Siemens laid before the meeting. Prof. Neesen gave the following explanation of this striking result: owing to the properties of the glowing steel, the rotating rollers seize upon only the outer layer of the steel cylinder and force this upwards, while at the same time the central parts of the cylinder remain behind. The result is thus exactly the same as is observed in the process of making glass tubes out of glass rods.

STOCKHOLM.

Royal Academy of Sciences, June 8.—Monograph of the Amphipoda Hyperiidea, part 2, by Dr. C. Bovallius.—Freshwater Algæ, collected by Dr. S. Berggren in New Zealand, and described by Dr. O. Nordstedt.—On a manuscript map of Scandinavia from the middle of the fifteenth century, found in the library of Comte Zamoisky, in Warsaw, by Prof. A. E. Nordenskiöld.—On the sequence of the Glacial beds, and on the temperature during the various stages of the Ice epoch, by Prof. O. Torell.—On the anatomy of *Hyperoodon diodon*, by Miss A. Carlsson.—Some reptiles and fishes showing the so-called third eye, exhibited and demonstrated by Prof. F. A. Smitt.—Desmidiaceæ from Greenland, described by Herr R. Boldt.—On the distribution of Desmidiaceæ in the northern regions, by the same.—Contribution to the knowledge of the anatomical structure of the Dioscoreæ, by Herr J. P. Jungner.—Studies on the spectra of absorption of the rare elements, by Prof. L. F. Nilsson and Dr. G. Krüss.—An attempt to calculate the dissociation in the water of solution, by Dr. S. Arrhenius.—Contributions to the theory of undulations in a gaseous body, by Prof. A. V. Bäcklund.—On the changes in volume and density of fluids through absorption of gases, by Dr. K. Ångström.—On the form of the crystals and twin-crystals of scolecite from Iceland, by Herr G. Flink.—Mineralogical notes, by the same.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

The British Moss Flora, Part x.: R. Braithwaite.—An Introduction to the Study of Embryology: A. C. Haddon (Griffin).—Pola seine Vergangenheit, Gegenwart und Zukunft; eine Studie (Wien).—Mount Taylor and the Zuñi Plateau: Capt. C. E. Dutton (Washington).—Bulletin of the U.S. Geological Survey, No. 38 (Washington).—Annalen der Physik und Chemie, 1887, No. 7 (Barth, Leipzig).

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