THURSDAY, MAY 29, 1879

HOW TO LEARN A LANGUAGE

How to Learn Danish (Dano-Norwegian). By E. C. Otté. (London: Trübner and Co., 1879.)

THE tourists who now crowd into Norway summer after summer are apt to find that a better acquaintance with the language of the country is required from them than is the case in the more frequented parts of Europe. They ought, therefore, to be grateful to Miss Otté for having provided them with an excellent manual for acquiring the necessary knowledge, since Danish is the language not only of Denmark but of the towns of Norway also, though more or less varying dialects are spoken by the peasants in the isolated dales. The manual is composed according to the Ollendorffian method; but a systematic grammar and rules for pronunciation are appended at the end, and the whole book is prefaced by an interesting and instructive introduction.

The Appendix corrects the chief defect of the method ot teaching foreign languages initiated by Ollendorff. This is its neglect to pay proper attention to so very important a matter as pronunciation and phonetics. Ollendorff seems always to presuppose the presence of a teacher who is either a native or else thoroughly acquainted with the phonetic peculiarities of the language he teaches. No doubt in learning a foreign tongue it is advisable to have such a teacher close at hand; but sometimes this is not possible, and the possibility is admitted by Ollendorff himself when he claims that his method will enable the pupil to dispense with a teacher altogether. It is clear, however, that Miss Otté, though she comes to the rescue of the student in regard to the pronunciation of Danish, has never paid very close attention to phonetics. The learner who tried to speak Danish in accordance with the rules of pronunciation she has laid down for him, would speak it with a very Anglicised accent indeed. Not a word is said even of that marked characteristic of Danish, the "stödtone" or glottal catch. For Danish pronunciation, it is desirable to consult Mr. Sweet's article in the *Transactions* of the Philological Society, 1873-4.

The very fact that so integral a part of language as phonology should be thus passed over in works intended to promote a conversational knowledge of foreign idioms shows the unsatisfactory character of our present mode of teaching languages, even at its best. It is based rather on empirical haphazard than on scientific principles. The method and results of comparative philology have as yet had but little influence on practical education. It is the old story of the divorce between the man of science and the man of practice, and, as usual, education suffers. If we would know how languages ought to be learned and studied we must give heed to the lessons of science which are also the lessons of nature.

Language consists of sounds, not of letters, and until this fact is thoroughly impressed upon the mind, it is useless to expect that languages will ever be studied aright. Language, moreover, is formed and moulded by the unconscious action of the community as a whole, and like the life of the community is in a constant state of change and development. Consequently we cannot compress the grammar of a language into a series of rigid rules, which, once laid down by the grammarian, are as unalterable as the laws of the Medes and Persians. On the contrary, grammar is what the community makes it; what was in vogue yesterday is forgotten to-day, what is right to-day will be wrong to-morrow. But above all, language, except for the purposes of the lexicographer, consists not of words but of sentences. We shall never be able to speak a foreign tongue by simply committing to memory long lists of isolated words. Even if we further know all the rules of the grammarians, we shall find ourselves unable in actual practice to get very far in stringing our words together or in understanding what is said to us in return. This was not the way in which we learnt our own mother-tongue, and if we would learn another language easily and correctly we must set about learning it as we learnt our own.

Ollendorff had the merit of seizing hold of this important fact, and to this his system owes the success it has obtained. Let the pupil first saturate his mind, as it were, with sentences or phrases; there will be plenty of time afterwards to analyse these into words and grammatical forms. We must begin with the whole, not with its parts; analysis is the task of science, not of practical education. But in both alike we must start with the known, or the best known; the unknown or less known to which we work back will differ according as our object is a scientific or a practical one.

If our object is the practical one of acquiring languages the less known will be those idioms which present special difficulties either through the strangeness and unfamiliarity of their structure and modes of expressing thought, or still more through their being now extinct. To learn a dead language in anything like a proper way is a very hard matter. We must first be able to think in other languages than our own and know what language really is; in other words, we must have a sound acquaintance with living tongues. Until we can realise that Greek and Latin are in no essential respect different from English, or French, or German, that they do not consist in a certain number of forms and rules learned by rote out of a school-grammar, or even in the polished phrases of a few literary men, but in sounds once uttered and inspired with meaning by men who spoke and thought as we do, the long years spent over Latin and Greek are as good as wasted. It were far better to fill our minds and store our memories with something which will be practically useful to us in after life and at the same time afford that mental training of which we hear so much. To begin our education with the dead tongues and afterwards fill up the odd intervals of time with a modern language or two is to reverse the order of science and nature. The necessary result is to produce a total misapprehension of the real character of speech, a permanent inability to gain a conversational knowledge of foreign idioms, and a false and generally meagre acquaintance with the classical languages themselves. It is not wonderful that the small modicum of Latin and Greek acquired during years of painful work at school should so frequently disappear altogether as soon as school is left, and considering the erroneous views this small modicum of learning implies it is perhaps hardly to be regretted that it should.

When a conversational knowledge of a foreign idiom has once been obtained and the pupil is able to think in another language than his own, the analysis and study of the idiom should be carried on in the light of comparative philology. He should be taught to see that the apparently arbitrary phenomena of language are all subject to strict law, and that the forms and words he uses all have a history and a reason for being what they are. In this way his intelligence as well as his memory will be excited and quickened, his curiosity, that "fountain-head of science," will be legitimately aroused and satisfied, and above all the conception of law will be made familiar to him from the first beginning of his education. When the action of philological laws has been traced and illustrated in modern languages, it will be easy to pass on to the dead ones and show how they are but the earlier forms of living speech, past links in the great chain of unbroken development.

Before parting from Miss Otté, allusion must be made to the reformed spelling of Dano-Norwegian and Swedish, which she has adopted in her Manual, and of which she has given an interesting account in her Introduction. This reformed spelling is in the first instance due to Rask, the great Danish philologist, but it owes its present acceptance to the Stockholm Conference, called together in 1869 by the exertions of Prof. Daa, and to the Dano-Norwegian dictionary which was the result of it. The vicious spelling of the past has now been superseded by a consistent and fairly phonetic one, based upon a scientific alphabet. In this respect the Danes have set us an example which it would be well to follow. The "practical men" of Scandinavia have at last condescended to listen to the recommendations of those who study language scientifically, and the people consequently now possess an orthography which forms no hindrance to learning to read and write and throws no veil over the true nature of speech. Let the Englishman who uses Miss Otté's Manual try to put himself in the place of a Dane who wishes to learn English, and then consider whether he does all in his power to facilitate the acquisition of at all events one language by the foreigner. A. H. SAYCE

LETTERS TO THE EDITOR

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

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

The Spectrum of Brorsen's Comet

I AM much obliged to Mr. Christie for his answer to my question. There can remain no doubt that Brorsen's comet does not *now* give the same spectrum as, according to Huggins's observations, it did in 1868. The difference in position between the brightest lines in the two spectra of carbon is, it is true, very small, but if it were possible it would be a step gained to decide which of the two lines the brightest comet band coincides with, 5198·4 or 5165·5, since as far as experimental evidence goes at present one of these lines is due to carbon-vapour and the other to an oxide of carbon. I fear that Prof. Piazzi Symth's theory that the spectrum in question is caused by hydrocarbon must be rejected for experimental reasons which I will presently recapitulate. I have had no experience in comet-spectroscopy, not having access to any telescope of sufficient aperture, and I do not wish, therefore, to seem to make light of the achievement of Mr. Christie and Prof. Young; but if it were possible to adjust the occulting bar so as to *completely* hide (but only *just* hide) the least refrangible edge of the brightest comet-band, then I should imagine that, on flashing in the spectrum of the alcohol-tube, its band would be seen beyond the bar if the comet-spectrum be, as is most probable, that which I have called "Carbon No. I."

At present the observations at the Royal Observatory seem to point to a coincidence with the second spectrum, but it was the *first* which Prof. Young employed and which Prof. Huggins also employed. A reference to Prof. Huggins's account of his experiments shows that the comparison-spectrum was obtained by taking the electric spark in olefiant gas at the ordinary pressure; and he further observes (*Quart. Jour. Science*, April, 1869) that "the same spectrum is given by the spark in cyanogen."

The difference between the spark in olefiant gas and in olive oil, shown in Huggins's diagram, is simply one of detail—the separate lines being distinctly seen in the spectrum of the oil and not in that of the gas.

Prof. Piazzi Smyth's alcohol-tube seems to differ from Mr. Christie's in containing besides the lines of spectrum No. II. (if he will allow me to call it so) the green band seen in the blue base of a candle flame—that is the band beginning with 5165·5.

This, I believe, is always the case if the vapour be at a somewhat high pressure. A reference to the *Phil. Trans.* for 1865, or the *Phil. Mag.* for October, 1869, will show that the tubes with which Plücker worked contained lines of both spectra—and that he did not succeed in completely separating the two. But a tube containing pure carbonic oxide at a small pressure (one or two millimetres) shows no trace of this green band even "end-on."

I cannot accept Prof. Piazzi Smyth's theory that this green band and the remainder of the lines in spectrum No. I. are due to hydrocarbon, for the simple reason that they are obtained brilliantly from substances which do not contain hydrogen, viz., cyanogen, carbonic oxide, and sulphide of carbon.

There is no more magnificent spectrum than the "carbon spectrum No. I.," obtained by burning cyanogen and oxygen together at the nozzle of an oxyhydrogen blow-pipe.

I should like to refer Prof. Smyth for other arguments than my own and for experimental evidence to a paper to be found in the *Ann. Ch. Phys.* for 1865, t. 4, p. 305.

Giggleswick, May 27 WILLIAM MARSHALL WATTS

A Universal Catalogue

THE last April number of NATURE contains an article on a Universal Catalogue, which seems to be still under discussion.

So great a work, when undertaken, should to a certain extent be complete, so as not to necessitate the same thing having to be done fifty times. With a really universal catalogue of books and memoirs existing, it would be quite easy for each library to form its own catalogue in a much abbreviated form. For instance:—

Brewster, Optics. 1831. P. 2350, or
Hauy, Crist. et Propr. phys. Enclase. 1819. Min. 6430,

would be quite sufficient to stand for—

Brewster, Treatise on Optics. London, 1831. Catalogue of Physical Science Papers, 2350. and
Hauy, Mémoire sur la Cristallisation et sur les Propriétés physiques de l'Enclase, Paris, Mus. Hist. Nat. Mém. v. 1819, pp. 278-293. Catalogue of Mineralogical Papers, 6430.

So in the library catalogues no cross references and main titles would be necessary, and no double and treble lines for titles of books or memoirs, five or six words and two numbers being sufficient to characterise each publication, while now, there being no general catalogue, each library desiring to give its catalogue—an undertaking which is highly desirable—is obliged to spend disproportionate cost, time, and space for such a purpose.

But scientific workmen would also be much better served in this way, as may be shown by the following facts:—

Putting the whole number of titles in the British Museum catalogue at 3,750,000 (1,250,000 real ones, 2,500,000 cross references, &c.), they may be classed into old and modern works, the former 750,000, the latter 3,000,000. Now, putting the number of special branches which deserve and imperatively demand special catalogues of subjects—as mathematics, botany, statistics, &c., &c.—at 50, and supposing that old books extend even 15 to 20 branches each, every special branch is represented by $\frac{750000}{50} \cdot 20 = 300{,}000$ titles of old publications and $\frac{3000000}{50} = 60{,}000$ of new ones.

So, one seeking for books of a single branch does not find more than 360,000 titles among 3,750,000, filling, when printed alone, 4·32, or in round numbers, 5 volumes of the 45, while he must undergo the trouble of using all the 45, or of this work, $\frac{40}{45}$, *i.e.*, 89 per cent. is useless and annoying for him, and $\frac{5}{45}$, or 11 per cent. only is useful; the space needed for the catalogue is about 4 metres, 44 centimetres of which are useful, and 3m. 56cm. disturbing; and, last but not least, he pays 36*l*. instead of 4*l*.

But with all this superfluous work, still no complete catalogue is acquired, but a very deficient one; for of periodical journal articles there are about 3,000,000, separate works about 6,000,000 in a rough estimation, or together, 9,000,000, *i.e.* (no main titles or cross-references being herein comprised), about six times the number possessed by the British Museum library.

Supposing, in the same proportion as above, these 9 millions of publications to be accompanied by 12 millions of main titles, &c.; supposing, then, these 21 millions of entries to be composed of 4·2 millions of old and 16·8 millions of new ones, the publication of these could be effected as follows:—

The titles of old books, being used much seldomer than new ones, and belonging mostly to fifteen to twenty different branches, could form a special catalogue of fifty volumes, whose price would be 40*l*.; each great city might content itself with a single copy accessible to all men of science.

The remaining 16·8 millions of modern publication titles, divided into fifty branches, would give 360,000 entries for each of them, or *five volumes for* 4*l*., so that even private libraries would be enabled to possess a complete catalogue of all modern publications of a single branch.

As to the construction of such catalogues, the following would perhaps be a practical method:—

At first a committee for the defining of branches and the limit between old and modern publications should be appointed, to which all greater libraries should send copies of their catalogue classifications; by means of these copies exact rules for the extent of branches and the method of working could be drawn up in six months.

This work done, a numerous catalogue committee should be formed, to which all greater library catalogues should be sent in copies; where such copies are wanting the library should be examined by members of the committee, using the thitherto ready part of the catalogues.

The periodical publications before 1800 and after 1873, should be registered in the same manner as those in the "Royal Society Catalogue," and then subdivided into single branches by the committee. In this way complete catalogues for great groups could be formed, care being taken not to restrict the limits of these too much in order to hasten the publication of the work. This publication would be the first and hardest step to a manageable index of literature.

During the next ten years after its publication the completion could be carried out by putting beside each title a short classification of its contents, not an extract—contained in a single word or phrase, like "electrostat." or "relat. age mortal.," for "electrostatics" or "relation between age and mortality," or a few single words when different matters are treated; these classifications, made simultaneously by different persons and compared, together with all corrections, could be printed about twelve years after the first catalogue, and form the final work, which at short intervals of five or ten years should be completed by appendices.

ARISTIDES BREZINA
Custos of the Imperial Mineralogical Museum, Vienna

Distribution of Mus rattus

I AM able to-day to complete my note in NATURE, vol. xx. p. 29, as to the exact habitat of the black rat in Thuringia. Prof. Liebe, of Gera, kindly wrote to me that it occurs in East Thuringia and the Voigtland in single elevated side-valleys of the rivers Weisse Elster and Roda, as well as in single lurking-places of the Frankenwald. Here it occurs in isolated forest-houses, in the valleys, in whole partly large villages, for instance, St. Gangloff. In this place for a long time past *Mus rattus* and *M. decumanus* have occurred together among each other, not one above the other, on different floors, as might be supposed, though *rattus* now and then rather prefers the upper floors, and the latter does not appear to be decreasing in number. In those villages about three specimens of *rattus* are always killed for one specimen of *decumanus*, the latter, apparently, being less numerous.

A. B. MEYER

Dresden, Royal Zoological Museum, May 20

Insect Galls Buds

I WAS much interested in Mr. A. Stephen Wilson's letter upon this subject (NATURE, vol. xx. p. 55). I must, however, demur to his statement that "all insect-galls are in reality leaf-buds or fruit-buds," as too sweeping to be accurate. I can hardly include in the above category the numerous galls which make their appearance on the growing leaves of trees, such, for example, as the oak-spangles (of *Neuroterus malpighii*) or the galls of the *Spathegaster baccarum*, *Andricus curvator*, &c, several of which may be placed on the veins of a single leaf. These examples cannot assuredly be classed as pathologically developed leaf or fruit *buds* only so far as woody growth usually takes place through buds. In a short paper I once read at the Linnean Society, an abstract of which appeared in NATURE during the early part of the year 1875, I drew attention to the fact that the growth of galls took place coincidently with the growth of the tissues in which they were placed; thus the development of the bud-galls of *Cynips kolleri*, *Teras terminalis*, and *Aphilothrix gemmæ*, is to be seen in the spring, summer, and early autumn, but not in winter time when the tree growth is arrested. My observations at that time led me to suppose that the currant galls of the oak and others of the same class only grow during the growth of the leaf to which they were attached.

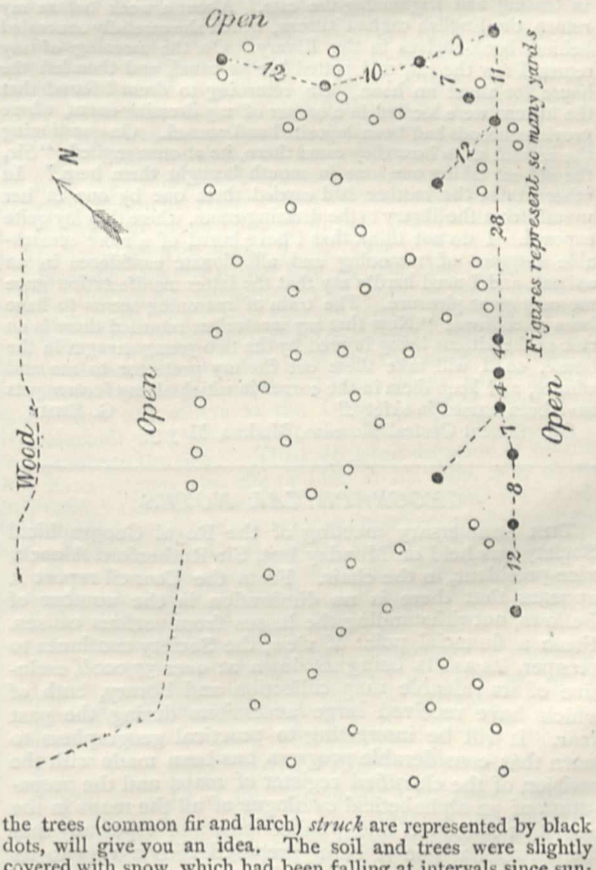
I trust Mr. Wilson will give your readers the benefit of his further researches on this subject.

W. AINSLIE HOLLIS

Brighton, May 16

Effects of Lightning

A REMARKABLE electric discharge occurred on Sir Robert Gordon's estate of Letterfourie in a small wood about four miles to the south-east of this place on November 16 last about 12.45 A.M. The accompanying sketch (scale $\frac{1}{24}''$ = one yard), where



the trees (common fir and larch) *struck* are represented by black dots, will give you an idea. The soil and trees were slightly covered with snow, which had been falling at intervals since sunset on the 15th. On that night I observed two or three flashes of lightning accompanied by thunder, and a few days afterwards

I was told by a local medical gentleman, who had visited the spot, that some eleven or twelve trees had been struck among the hills under peculiar circumstances. The snow was lying so deep at the time that the place was well nigh inaccessible, and owing to want of leisure and the continued severe weather, I had no opportunity of visiting the wood in question until a few days ago. I then ascertained from a farmer living 150 yards south-east of the spot, that the trees must have been struck simultaneously.

Between 9 and 10 P.M. on the 15th a flash of lightning, followed by loud thunder, was seen by him in the north and clear of the wood altogether; besides, the interval between flash and peal showed it to be at a comparatively great distance. The man, being an invalid, never slept, when about 12.45 A.M. on the 16th a blinding light immediately followed by a tremendous thunder-clap made him think his own house was struck. The next and last flash and peal occurred a quarter of an hour afterwards at a considerable distance away to the west.

The effect of the lightning on the trees was observed from the window on the following morning, and as the spot was daily visited by the inmates of the house for the purpose of drying clothes, there could be no doubt but the damage had been done during the previous night. All the fourteen trees, varying from six to nine inches in diameter, and not visibly higher than the immediately adjoining ones have lost the bark over a width of one half to one inch, and the wood is slightly split.

Buckie, Banff, N.B., May 12 G. W. CAMPHUIS

Intellect in Brutes

IN connection with recent correspondence in your columns, it has occurred to me that the following remarkable instance of reasoning in an animal might be of interest to your readers.

In 1877 I was absent from Madras for two months, and left in my quarters three cats, one of which, an English *tabby*, was a very gentle and affectionate creature. During my absence the quarters were occupied by two young gentlemen, who delighted in teasing and frightening the cats. About a week before my return, the English cat had kittens, which she carefully concealed behind book-shelves in the library. On the morning of my return I saw the cat, and petted her as usual, and then left the house for about an hour. On returning to dress I found that the kittens were located in a corner of my dressing-room, where previous broods had been deposited and nursed. On questioning the servant as to how they came there, he at once replied, "Sir, the old cat taking one, one in mouth brought them here." In other words, the mother had carried them one by one in her mouth from the library to the dressing-room, where they lay quite exposed. I do not think that I have heard of a more remarkable instance of reasoning and affectionate confidence in an animal, and I need hardly say that the latter manifestation gave me very great pleasure. The train of reasoning seems to have been as follows: "Now that my master has returned there is no risk of the kittens being injured by the two young savages in the house, so I will take them out for my protector to see and admire, and keep them in the corner in which all my former pets have been nursed in safety." G. BIDIE

Government Central Museum, Madras, May 3

GEOGRAPHICAL NOTES

THE anniversary meeting of the Royal Geographical Society was held on Monday last, Sir Rutherford Alcock, vice-president, in the chair. From the Council report it appears that there is no diminution in the number of Fellows, notwithstanding the losses from various causes. From a financial point of view, the Society continues to prosper, its assets being set down at over 37,000*l.*, exclusive of its valuable map collection and library, both of which have received large accessions during the past year. It will be interesting to practical geographers to learn that considerable progress has been made with the revision of the classified register of maps and the preparation of an alphabetical catalogue of all the maps in the Society's collection and publications, and especially that the new catalogue is being prepared with a view to its being subsequently printed. We are also informed that a case containing a set of traveller's instruments, such as the Society recommend, has been placed in the map-room. At the conclusion of the report the royal medals were presented to Count Schouvaloff, the Russian ambassador (for Col. Prejevalsky), and General Sir Lintorn Simmons, R.E., G.C.B. (for Capt. W. J. Gill, R.E.), after which came the presentation of the Public Schools' Prize Medals, the award of which we have already recorded, and some interesting remarks on the teaching of geography, by the Rev. G. Butler, head-master of Liverpool College. The Hon. G. C. Brodrick announced the subject for next year's examination would be "Western Africa, from the Sahara to the Congo, and as far eastwards as Nyangwé." The Earl of Northbrook was elected president, and among the new members of council are General R. Strachey and General Sir H. L. Thuillier, late head of the great Trigonometrical Survey of India, both of whom are well known as scientific geographers. The Society being without a president, the annual address on the progress of geography was delivered by Mr. Clements R. Markham, the senior secretary. The chief items of news are that Lieut. R. C. Temple, of the 1st Gurkhas, has constructed a map of a large tract of previously unknown country between Candahar and Dehra Ghazi Khan, and has promised to furnish an account of the region, and that Mr. Whitely is about to attempt an examination of the mysterious Mount Roraima and its neighbourhood, in the interior of Guiana. In conclusion, Mr. Markham called attention to the shortcomings of the Admiralty in the surveying department, expressing a hope that they might be induced to send out a properly equipped surveying-vessel to the southern part of the east and west coasts of Africa, "which have not been sounded since the days of Capt. Owen, half a century ago."

M. SOLEILLET, who recently tried to reach Timbuctoo, has arrived in Paris, and gave, on Monday, an address before the Société d'Études Maritimes et Coloniales, in the large hall of the Société d'Encouragement. M. Soleillet is in very good health, and no trace of his illness is now visible. He speaks highly of the negro population and the Sultan of Segou, where he spent more than three months as peaceably as in any French town, without any other escort than a single servant, a sergeant of the Senegal Rifles. The Niger at Segou-Sokkhora, more than 2,000 miles from its mouth, is about 300 yards wide. The access is very easy for traders. M. Soleillet will devote his future exploration to the determination of the best track for the trans-Saharan railway. He contrasted the good will of the negro population for the French with the hostility exhibited towards Europeans in the Sahara.

FROM *Globus* we learn that the long sojourn of the Russian troops in Bulgaria and Rumelia has been fruitful of results to geographical knowledge. The Russian staff have been active in carrying out a series of astronomical and geodetic observations, so that a fairly complete network of triangulation has been accomplished, which will enable cartographers to lay down with fair accuracy a very considerable number of places in our maps. Something like 1,000 points have been thus taken, most of them geodetically, but a considerable number astronomically. The chief results are expected to be published by 1880.

THE steamer *Nordenskjöld*, Capt. H. Sengstacke, formerly chief officer of the *Germania* on the second German Arctic expedition, sailed from Malmö, under the Russian flag, on May 12, for Behring Strait, *viâ* the Suez Canal. On board are Prof. Grigorieff of St. Petersburg, and Baron von Danckelman of Leipsic, to whom are intrusted the duties of zoologist and physicist respectively. The object in view, as our readers know, is to visit the mouth of the Lena, and, if necessary, render assistance to Prof. Nordenskjöld. The expedition is not over-manned, as it consists but of sixteen persons, including officers, *savants*, two engineers, and three stokers. It is possible that by this time Nordenskjöld may have broken out of the ice and be on his way home by the Suez Canal. The letters received from him, referred to last week, are, Mr. Oscar Dickson informs us, dated February 8.

LETTERS from Prejevalsky, dated from Zaisan, March 20, inform us that the deep snows which cover the steppes had detained him there much longer than he had calculated. He was, however, to leave on March 21, and expected to reach Khami at the end of May, by way of the River Urunga and the southern spurs of the Altaï; unless prevented by excessive heat and want of water, he was to pursue his journey to the town of Shachjeou. Then he would attempt to ascend the two plateaux of Tibet; after ascending the second plateau he would have 1,000 versts of desert to make before reaching Lassa, from which he hopes to visit South-east Tibet.

A COMPLETE history of all North Polar Expeditions from the remotest ages down to the present day is about to be published by Cotta of Stuttgart. The title will be "Im ewigen Eis," the author is the popular writer, Herr Friedrich von Hellwald. Numerous illustrations, maps, and plans will enhance the value of the work, which will appear in thirty parts. The well-known explorer, Julius Payer, one of the commanders of the Austrian Polar Expedition in 1874, has accepted the dedication of the work.

FROM the *Colonies and India* we learn that a private telegram from Aden conveys intelligence of the arrival there on the 15th inst. of the British India Steam Navigation Company's steamer *Chinsura*, from Bombay, *en route* for Zanzibar, having on board four Indian elephants, the property of the King of the Belgians. These elephants will be employed for the purpose of ascertaining whether such animals can be made a means of transport in Africa.

THE Inter-Oceanic Canal Congress has been diligently carrying on its work in Paris for the last fortnight. It was divided into several sections, each to consider a special department of the subject. On Monday the Technical Section of the Congress met to hear reports from its two sub-committees, the second of which admitted the possibility of constructing a canal with locks by way of Nicaragua, while for a level canal it considered the course proposed by Lieutenants Wyse and Reclus to be the best, subject, however, to certain modifications. The first sub-committee presented estimates of the probable cost of the various routes.

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF MAY 22, 1724.—In the *Illustrated London News* of Saturday last are some quaint extracts from the newspapers of the time, relating to this eclipse, the last that was total in England. It may not be without interest to examine the general circumstances of this phenomenon, which we are now enabled to do with much precision, by taking advantage of the data furnished in Prof. Newcomb's recently published "Researches on the Motion of the Moon." The elements are as follow:—

G.M.T. of Conjunction in R.A., 1724, May 22, at 5h. 26m. 33s.

	°	′	″	
Right Ascension	59	32	12·8	
Moon's hourly motion in R.A.		38	21·1	
Sun's „ „		2	30·4	
Moon's declination	21	5	7·4	N.
Sun's „	20	31	28·9	N.
Moon's hourly motion in declination ...		10	53·3	N.
Sun's „ „ „ ...		0	29·0	N.
Moon's horizontal parallax		60	44·5	
Sun's „ „			8·7	
Moon's true semi-diameter		16	33·1	
Sun's „ „		15	47·4	

The sidereal time at Greenwich mean noon on May 22 was 4h. 1m. 3·6s., and the equation of time at conjunction in R.A. was 3m. 49·1s. additive to mean time.

Hence it appears that the central eclipse began at 3h. 41·6m. in long. 151° 39′ W., lat. 13° 55′ N.; it occurred with the sun on the meridian in long. 82° 36′ W., lat. 54° 30′ N., and ended in long. 11° 57′ E., lat. 45° 28′ N., or the sun set centrally eclipsed near Padua.

It was therefore late in the afternoon with the sun at small altitude that the eclipse was witnessed in these islands, and the following figures must very nearly define the course actually pursued by the moon's shadow:—

LONGITUDE.	LATITUDE. N. Limit.	LATITUDE. Central Line.	LATITUDE. S. Limit.
	° ′	° ′	° ′
4° W. ...	52 37 ...	51 29·9 ...	50 24
2° W. ...	51 57 ...	50 49·5 ...	49 43
0° ...	51 15 ...	50 7·6 ...	49 1
2° E. ...	50 32 ...	49 24·4 ...	48 18

The popular interest excited in this eclipse we may infer was mainly due to the publication of a chart of its track by Halley, then Astronomer-Royal. A copy of this chart is preserved at the apartments of the Royal Astronomical Society; it is entitled "A Description of the Passage of the Shadow of the Moon over Europe, as it may be expected May 11, 1724, in the Evening, by Edm. Halley, Ast. Reg." It was "Engraved and Sold by John Senex at the Globe against St. Dunstan's Church in Fleetstreet, Price 1*s*." Halley concludes some footnotes as follows:—"At London we compute y^e Beginning at 5h. 40m. P.M., y^e Middle, when it will be nearly Total at 6.37, and y^e End 7.29. We wish our Astronomical Friends a clear Sky."

It will be borne in mind that the old style was still in use in this country in 1724, and the eclipse was thus dated May 11. Halley's predicted track is in very close accordance with that we have obtained above. His chart shows the central eclipse passing just south of Wexford, north of Bridgwater, over the Isle of Wight and south of Dieppe to near Venice; his northern limit of total phase passes just south of Dublin, over Leominster and Oxford, and Brentford near London, by Cambray and just north of Strasburg; the southern limit passes a little south of Kinsale, Padstow, Chartres, &c.

Dr. Stukeley observed the eclipse from Haradon Hill, near Amesbury, Wilts, and the account of it which he published in his *Itinerarium Curiosum* has been frequently transferred to our popular works. Assuming his position to have been in about 1° 47′ west of Greenwich, with a latitude of 51° 11′, we find by the above elements that totality would commence at 6h. 26m. 0s. local mean time, and continue 2m. 34s., the sun being at an altitude of 12°. The eclipse was central at or close to Ventnor, and was total there for 2m. 47s.; the newspaper of the time says, more than 1½ minute. Observations were made by Delisle and others at the Observatory of Paris, and by Maraldi and Cassini, at the Trianon, Versailles, "en presence du Roy." The calculated duration of totality at Paris is 2m. 23s., the middle at 6h. 49m. 41s. apparent time; Gaudin observed the duration 2m. 22s., and the middle at 6h. 50m. 2s.; other observers made the duration twenty seconds longer, which is certainly an error; at the Trianon it was observed to be 2m. 16s., a little less than the calculation makes it. The original observations of the French astronomers are given at p. 129 of Prof. Newcomb's work.

The next total eclipse of the sun visible in England will take place early on the morning of June 29, 1927, but totality will only continue some ten seconds.

THE MIGRATION OF BIRDS

IN a reply of Dr. Weismann's to some remarks by Prof. A. Newton in his paper on the migration of birds (NATURE, vol. xix. p. 579), a statement of mine is quoted to the effect that "in July young starlings pass over Heligoland by hundreds of thousands *without a single old bird* accompanying them," the learned Doctor adding that he "cannot regard this as a *fact*, but as a more or less probable *conjecture*." This is a rather bold and unceremonious assertion. As, however, Dr. Weismann, with reference to the above, and to the autumnal passage of young birds prior to their parents in general, puts the question "*but are these really facts?*" admitting that if they were they would "seem to be against the sufficiency of the five senses"—and as in any probable future efforts of the learned gentleman's on the above topic, incontestable *facts* might prove infinitely more useful than ever so voluminous an amount of nicest *conjecture*, I beg to be allowed to contribute some statements bearing on the question, which are based on daily observations of mine now extending over a period of more than forty years, and made on Heligoland—than which an observatory more favoured for such purposes the rest of Europe may not afford.

Personal experience the learned Doctor does not seem to command respecting the migratory movements of birds, otherwise it might be supposed that he would have brought forward the results of his observations either in refutation of mine, or in confirmation of the same, and I cannot help adding that in my humble opinion, the treatment in whatever form of so grand and mysterious a phenomenon as the migration of birds, should be preceded by a study of the same in nature, if only it were in its simplest outward appearances. Such a proceeding would prevent the continual repetition of certain traditional errors, and of the building thereon of fallacious inferences and hypothetical assumptions.

But to return to the starlings in question. The learned Doctor maintains that I "could not possibly have inspected a hundredth part of these 'hundreds of thousands' of starlings flying about." Now, to a Heligolander, such a view of the question would, if anything, be most amusing. I fully uphold what I stated: all these birds touching Heligoland *are* inspected, and I may add that such is done by the most competent judges, who, in fact, think very lightly of distinguishing a young starling passing overhead from an old one.

When, in my correspondence with Prof. Newton, I drew his attention to the fact of the autumnal movement of young birds taking place from one to two months prior to that of their parents, I purposely referred to a species affording the most easy means for observations corroborative of my views, viz., the common starling. This bird is one of the very few species which perform their migratory flights at so moderate an altitude as to permit of the most satisfactory scrutiny of each individual of a whole flock. Besides such a scrutiny is greatly facilitated by the different colour of the old and young birds at the season in question; the former, on the wing or on the ground, appearing at any distance perfectly black, whilst the latter are of a very light brownish-grey colour, verging underneath on a soiled white; the entire appearance of both differing to such an extent that if a flight of these birds were passing overhead at a height from fifty to three hundred feet, consisting of even a thousand individuals, it would require but the most cursory glance forthwith to detect a single old bird among the whole number. That such appears so very incredible to Dr. Weismann only proves how very little practice he can have had in these matters.

Moreover, a very great proportion of these young starlings alight for some hours on the upper plateau of the rock, and furnishing, in contradistinction to the old tough birds, a rather dainty dish, they are pursued by the Heligolanders very eagerly, and shot in great numbers; the island taxidermist, Aeukeus, for instance, succeeding last summer in bagging *eighty-three* such young birds at the discharge of his two barrels. This latter incident alone may prove what quantities of these birds are captured here during the month of July of each succeeding year, and I repeat, they never contain the slightest admixture of old black specimens.

The above I suppose will be admitted as sufficiently *demonstrative facts*, and will I trust exculpate me from "building far-reaching theoretical inferences," a proceeding against which the learned doctor gravely says we must guard. May I be permitted to ask: to *whom* is this warning given? for hitherto I was rather given to believe that conjectures, theoretical inferences, and the like generally grow much more luxuriantly beneath the limited light of the study-lamp than in the face of free matter-of-fact nature.

Here may follow a few data respecting the periods of passage of the old and young starlings as noted down from daily observations, and I leave it to Dr. Weismann to admit the same as the documentary evidence of an "excellent ornithologist," as he so courteously terms me, or perhaps to dismiss them as of undemonstrated validity.

Sturnus vulgaris.—First week in June, 1878, some solitary old birds of extremely abraded plumage—supposed to be individuals that had lost their mates or were otherwise disturbed whilst breeding.

June 20 and 21, great flights of young birds; 22nd, 23rd, and 24th, enormous numbers of young birds; up to the end of the month thousands of young birds daily.

July 1 to 12, from a thousand to ten thousand young birds daily; 16th, many flights of hundreds; 25th, great many young birds.

Then follows a pause of two months during which no starlings whatever were seen, the migratory move being taken up again on September 22, when I find noted down:—

Starlings, old birds in fresh plumage, flights of many hundreds.

October 2 and 7, great many old birds; 8th, flights of thousands; 13th, Royston crows and old starlings by tens of thousands; 14th, crows many thousands, starlings hundreds of thousands; 15th, many; 16th, a few only; 20th, tens of thousands; 28th, great many.

November 18 and 19, flights from twenty to fifty.

December 9 to 18, flights from forty to sixty daily.

Thus I have witnessed the autumnal migration of the old and young starlings during the long series of years above stated. Invariably nothing but young grey birds pass over here (and in a broad front extending to both sides of the island) from the latter part of June to the end of July; then a pause ensues lasting from six weeks to two months, when during the latter part of September the movement is taken up again by the old birds in fresh black plumage, and continued to the close of November—by straggling parties oftentimes kept up till Christmas.

These are incontestable facts, however incredible they may appear to Dr. Weismann; but he may rest assured that not only all the young and old starlings passing over here *are* "*inspected*," but the many hundreds of thousands of miscellaneous birds visiting this island have to pass a very critical review in addition.

I cannot conclude these remarks respecting the question of young birds preceding during their first migratory trip their parents by one or two months, without stating that, so far as my long experience on Heligoland extends, there exists, among the 360 odd species collected here by myself, only one solitary exception to the general rule, viz., the cuckoo, *Cuculus canorus*, of which species the *old birds precede* their young by at least four weeks. Of all the rest, the young birds of the summer open the grand autumnal flight, *unaccompanied by any old*, the very finest old males at the close of the season bringing up the rear. In spring, however, *quite the reverse invariably takes place*, then the most perfect old males appear first, followed soon by old females, and later by younger birds of less perfect appearance, in this instance the rear being brought up by the halt and lame: crippled birds that have lost a greater or less number of their wing or tail feathers, some toes, or even a whole foot.

All this is very strikingly exemplified here by the blackbird, for instance, with its varying dress according to age and sex, and this might with some attention be observed at other places also, though in the middle and south of England and Germany such observations become greatly more complicated, on account of the immigrants from the north mixing with such of the same species as have been breeding in these more southern latitudes, and where the grand opening migratory rush, as witnessed here in full original purity, has more or less relaxed in a *con amore* travelling by easy stages. H. GÄTKE

Heligoland, May 7

THE U.S. NATIONAL ACADEMY

ONE of the chief scientific events of the year in the United States is the annual meeting of the National Academy of Sciences, the most select scientific body in America, election to which is regarded as stamping a man as an acknowledged leader in science. This year the meeting took place at Washington from April 15 to 18, the acting president being Prof. O. C. Marsh, who opened the proceedings with a review of the Academy's official work during the previous year. He had to record the great loss sustained by the Academy in the death of its president, Prof. Joseph Henry, on May 13 last year. Henry had been president of the Academy for ten years. One of the principal functions of the Academy during the past year was the consideration of a plan for the reorganisation of the U.S. Surveys, to which we have already referred at length.

At the meeting of the Academy in April last year a resolution was adopted authorising the appointment of a committee to consider a plan proposed by Prof. Newcomb for determining the distance of the sun by measuring the velocity of light. In accordance with this vote, Prof. Marsh appointed as members of the committee, President F. A. P. Barnard, Professors Wolcott Gibbs, Henry Morton, George F. Barker, and E. C. Pickering. Their report was so favourable to the plan proposed that Prof. Marsh sent it to the Secretary of the Navy for transmission to Congress. An appropriation of 5,000 dols. for the required purpose was thus secured, and the work of constructing the necessary apparatus will be commenced as soon as the appropriation is available. The expenditure of the funds is entrusted to the Secretary of the Navy. It is hoped by those who proposed this plan that the experiments will lead to a more accurate determination of the distance of the sun than can be obtained by any other method known to astronomy.

Prof. William B. Rogers was elected President of the Academy, to fill the vacancy caused by the death of Prof. Henry. The election is a deserved tribute to Prof. Rogers, who has for half a century held a prominent place among American men of science. He was for many years a leader among American geologists in adopting the modern theories of evolution, and defended his views with rare eloquence as well as strong argument. During his connection with the Massachusetts Institute of Technology (1862–68), the health of Prof. Rogers became so much impaired that he was obliged to withdraw from all studious pursuits for a long period. His recovery of health was the occasion of hearty congratulation in 1875, when he was for a second time elected President of the American Association for the Advancement of Science. The new president is loved by everybody, is venerable with silver locks, and still retains the silver-tongued eloquence for which he used to be famous. But he is by no means rugged, and has to take care not to over-exert himself.

Many valuable papers were read during the meeting of the Academy, but our space will only permit of our referring to a few. We append a complete list, and those who desire a complete report of the Academy's proceedings will find it in *Science News* of May 1 and following numbers.

Two papers were presented by Mr. Peirce, entitled respectively, "On Ghosts in Diffraction Spectra" and "Comparison of Wave-Lengths with the Metre." It is well known to users of diffraction spectroscopes that ghosts of the lines appear in the images. Mr. Peirce has investigated this subject from a mathematical point of view, and he presented to the Academy a series of calculations based on the conditions which call forth these ghosts, and concluding with formulæ for determining their positions. In conjunction with Mr. Rutherfurd, Mr. Peirce has been investigating the relation of the wave-lengths of light to the metre. The object is to obtain a basis for measuring the standard metre. The metres that have been issued as standards change in length after a lapse of time. The German metre is said to differ from the French metre by one 25,000th. Mr. Peirce proceeded on the assumption that the wave-lengths of light are of a constant value. Certain questions have arisen in the course of this research. It was necessary to ascertain whether the spectral lines were fine enough to serve the purpose. There was a doubt as to whether the lines were displaced by "ghosts," and this led to the mathematical inquiry, previously alluded to, which has defined the position of ghosts relatively to the lines. Again, it was found needful that the spectrum to be observed should be at its maximum of brilliance. It had been noticed that two spectra composing a pair (that is, of the same order) are usually of different brightness, the right side spectrum differing from the left side one. This was specially true of spectra obtained from ruled glass; those from speculum metal were not so notably diverse in brightness. Examination showed that this characteristic was due to a difference in the sides of the groove ruled in glass. The diamond, in ploughing through the surface, raises a burr on the side of the furrow, and hence makes the two sides of the cut of unequal height. At first it was attempted to remove this imperfection by rubbing off the burr; but it was found that the material of the burr went to fill up the groove, and thus rendered the glass plate unserviceable. But, by first filling the groove with black-lead, then polishing off the burr, and finally removing the black-lead, plates were obtained that gave spectra of the utmost brilliancy, and the right and left spectra of each pair did not differ in brightness from each other. Mr. Peirce also gave the particulars of other improvements recently made in spectroscopic apparatus. One of these involved the construction of glass circles, and the work was so delicate that a well-known instrument maker had failed in four attempts. A method was described by which the accurate focussing of the heliostat—a matter of great importance—had been satisfactorily attained. The experimenters have succeeded in measuring a number of decimetre scales by centimetres. The probability of a single error is within the fiftieth part of a micron. (A micron is as much smaller than a millimetre as the latter is less than a metre.) Means have been devised which keep the apartment, where the experiments are made, at a fixed temperature, within one-tenth of a degree of Fahrenheit. With a sufficient number of observations, and the use of apparatus having their latest improvements, these experimenters hope to attain the object of their research, and limit the error to one-millionth part of a wave-length.

Prof. E. C. Pickering's paper on eclipses of Jupiter's satellites was one of considerable importance. He showed the value of the photometric method of observing these eclipses, and the valuable data that might be obtained by improvements in this method, both as to the sun's distance and as to Jupiter himself and his satellites.

In a paper on the winds on Mount Washington compared with the winds near the level of the sea, Prof. Elias Loomis came to the following conclusions:—1. In a majority of the cases where an area of low barometer passes over New England, attended by the usual circulating winds at the surface stations, this system of circulating winds does not extend to a height of 6,000 feet. 2. This system of circulating winds extends to the greatest height when the depression of the barometer is unusually great. 3. When, during the progress of an area of low pressure, a system of circulating winds reaches to the summit of Mount Washington, the change of wind to the east quarter usually begins at the surface stations eleven hours sooner than on the summit of the mountain; and the change back from east to west usually begins five hours sooner at the base than at the summit.

Prof. Joseph Le Conte's paper on the extinct volcanoes about Lake Mono, and their relation to the glacial drift, was of much interest. The general form of the Sierra is that of a great wave, ready to break on its eastern side. It rises from the San Joaquin Plains by a gentle slope of fifty to sixty miles, reaches a crest 13,000 feet high, and then, in a space of five or six miles, plunges downward steeply to the plains of Mono, which are at an altitude of only 6,000 feet. In former periods, long, complicated glaciers, with many tributaries, occupied the western slope; on the east, comparatively short and simple glaciers came down in parallel streams, and stretched far out on the plain and into Lake Mono, which was then 700 feet above its present level, and of far greater extent than now, so that it washed the base of the Sierra. Icebergs from the glaciers floated on this inland sea and dropped *débris* on its bottom. Around the present lake is a nearly level desert plain, covered with volcanic sand, interspersed with fragments of pumice and obsidian, and overgrown with sage-brush (*Artemisia tridentata*). This plane is an old lake bottom; the volcanic ashes are a later deposit upon it. The desert is relieved by the Sierra walls, with deep cañons; by long parallel moraine ridges, stretching like arms from the mouth of each cañon, and bounding the pathways of ancient glaciers; by a cluster of recently extinct volcanic cones, fifteen or twenty in number; and, finally, by the bright waters and picturesque islands of the lake. The moraines average 300 to 406 feet in height, and five or six miles in length. Lake Mono is ten by fourteen miles in extent. Having no outlet, its waters are saline—essentially a strong solution of sodium carbonate, with smaller proportions of calcic carbonate, common salt, and borax. Four to six terraces are very distinct about Lake Mono. Some of these are traceable all the way around it; the highest is, according to Whitney, 680 feet. They are undoubtedly the remains of former lake-levels. The highest level would reach the moraines at the foot of the Sierra. Near the centre of the lake is a group of volcanic islands in a line with the group of volcanic cones on the plain to the southward. Steam and boiling water issue in many places in the rocky part of the island and in the shallow waters of that vicinity. The twenty or thirty volcanic cones on the plain vary in height from 200 to 2,700 feet above the plain. Some of them are probably recent, and retain a perfect form. Prof. Le Conte adduced evidence to show that the eruptions were—at least in part—more recent than the glaciers, and that many of the volcanoes themselves were also of later date than the Champlain epoch to which the glaciers are assigned. From his observations on Lake Mono, Prof. Le Conte concluded that its level is again rising, and that this had been going on for ten or fifteen years. He found near the margins of the lake, sheep-corral fences and old trails, submerged many feet. He also found dead sage-brush (*Artemesia tridentata*) and greasewood (*Sarcobatis vermiculatus*), that were under five feet of water. Neighbouring residents estimate the rise of the lake as ten to twelve feet in ten to fifteen years. The cause is evidently an increase of rainfall, and especially of snowfall. With regard to a moving snowfield, or rather an imperfect glacier, on Mount Lyell, Prof. Le Conte finds signs that the ice is advancing.

In a paper on vowel theories in the light of recent experiments with the phonograph, Prof. Graham Bell discussed the whole subject, and gives an account of his own recent experiences. Prof. Bell formulates his research as follows:—We may adopt the "fixed pitch theory," which supposes that the partial tones characteristic of vowel sounds have fixed, invariable pitches; and the element of pitch may be considered the distinguishing feature; or we may adopt the "harmonic theory," which assumes that the partial tones are harmonics of the fundamental, varying in pitch with it; the vowel characteristic lying in the predominance of certain harmonics. The fixed pitch theory finds much support from a consideration of the mechanism of speech. Various experiments, of which Prof. Bell exhibited a considerable number, tend to bias the mind in favour of this theory. But in a series of careful experiments with the phonautograph it was found that (1) Vowel sounds uniformly produced periodic curves, whatever pitch of voice was employed; (2) The form of vibration was not a stable phenomenon; (3) Different vowels, sung to different pitches, often produced sensibly similar curves; (4) Different vowels sung to the same pitch yielded curves of different shapes; but the differences were not so well marked as to identify the vowels; (5) The size of the aperture seemed to influence the complexity of the tracing. Prof. Bell tried a phonautograph made with the tympanic membrane of the human ear, but obtained no different results. The general indications of the phonautograph thus favour the harmonic hypothesis. The phonograph was finally tried to help in solving this problem. Other experimenters have tested the instrument on this point. After describing their experiments and results, Prof. Bell gave the details of his own. By changing the speed of the phonograph, such words as "mean, mane, men," were altered (approximately) to "moon, moan, morn," and the reproduced ee became a faint oo. Different opinions as to these sounds are entertained by others who have experiments of a similar character, but all of the numerous researches made on this subject confirm Prof. Bell in his view that the phonograph answers the question of vowel fixity in the negative. Some very recent experiments, made by Prof. Bell and Mr. Francis Blake, conjointly, not only demonstrate that the vowel quality changes under varying speed of the phonograph cylinder's rotation, but also show the direction and nature of the change. This was shown by starting the cylinder at a given velocity, and letting it slowly come to rest. During this reduction of speed the vowel-sound "ah" changed successively from "ah" to "awe," "oh," and "oo." (The same effect can be produced by gradually contracting and rounding the orifice of the lips, while, at the same time, the back of the tongue is slightly raised.) With decreasing rapidity of the cylinder, the prime tone and the partial tones fall simultaneously in pitch. If a gradually increasing velocity was employed, the vowel-sound "ah" gradually changed to that of "ir" in "sir," and then to that of "a" in the word "man." Meanwhile, the quality of the sound became metallic. These facts favour the fixed pitch theory. Prof. Bell approves the suggestion of Ellis, that "what we call our vowels are not individuals—scarcely species—but rather genera, existing roughly in a speaker's intention; but at present mainly constituted artificially by the habits of reading and writing. Of the two hypotheses it is certain that one (the harmonic) is wrong, and the other only partly right. Treating vowels as we find them—as genera of sounds instead of individuals—the most plausible theory seems to consist in what we may term the "Harmonic Fixed Pitch Theory," according to which a vowel is a musical compound composed of partial tones whose frequencies are multiples of the fundamental of the voice, the predominant partials being always those that are nearest in pitch to the resonance cavities formed in the mouth by the position of the vocal organs assumed during the utterance of the vowel. An interesting discussion followed the reading of this paper. Prof. A. M. Mayer remarked that it is exceedingly difficult to obtain uniformity of results in analysing vowel-sounds. One curious experiment made by Prof. Mayer consisted in covering the ears of a human subject with soft wax, so that they were hermetically sealed, and then applying to the top of the head an instrument which gave forth a certain note. The person thus treated heard the note one octave higher than it was actually sounded. On the whole, it must be admitted that we know very little of physiological acoustics.

The following is a list of the papers read at the meeting of the Academy:—

C. S. Peirce—On Ghosts in Diffraction Spectra; On Comparison of Wave-lengths with the Metre; On a Method of Swinging Pendulums, proposed by M. Faye; On the Errors of Pendulum Experiments; On Projections of the Sphere which still Preserve the Angles. S. H. Scudder—The Palæozoic Cockroaches. Henry Draper—Conformation, by Spectrum Photographs, of the Discovery of Oxygen in the Sun. S. Weir Mitchell—The Relation of Neuralgic Pains to Storms and the Earth's Magnetism. Joseph Le Conte—On the Extinct Volcanoes about Lake Mono, and their Relations to the Glacial Drift. E. D. Cope—On the Extinct Species of the Rhinoceros, and Allied Forms of North America. E. W. Hilgard—The Loess of the Mississippi and the Æolian Hypothesis. J. E. Hilgard—An Account of Geodetic Arcs determined by the Coast Survey in Relation to the Figure of the Earth; an Account of Recent Comparison of the British Imperial Standard with its Copies sent to the United States. J. E. Hilgard—Report of Progress of the International Bureau of Weights and Measures at Paris. G. K. Gilbert—On the Stability and Instability of Drainage Lines. E. C. Pickering—Eclipses of Jupiter's Satellites; two New Forms of Micrometer. C. V. Riley—The Hibernations and Migrations of *Aletia argillacea* (the parent of the cotton-worm). Alfred M. Mayer—Description and Exhibition of a

New Form of Heliostat. C. F. Chandler—A New Polariscopic Method for the Detection and Estimation of Dextro-glucose in the Presence of Cane Sugar and Inverted Sugar. A. Graham Bell—Vowel Theories considered in the Light of Recent Experiments with the Phonograph and the Phonautograph. Elias Loomis—The Winds on Mount Washington Compared with the Winds near the Level of the Sea. Henry L. Abbot—The Ignition of High Tension Fuses. Alexander Agassiz—Report on Dredgings in the Caribbean Sea by the Coast Survey Steamer *Blake*, Commander, John R. Bartlett, U.S.N. C. F. Chandler—On Two New Diazo Colours from Coal Tar. G. J. Brush—On a Mineral Locality in Fairfield County, Connecticut. H. A. Newton—On the Influence of Jupiter on Bodies passing near the Planet. J. S. Newberry—On the Great Silver Deposit recently Discovered in Colorado, Utah, and Nevada. Simon Newcomb—On the Recurrence of Solar Eclipses. F. A. P. Barnard—Report of the Committee on Weights, Measures, and Coinage.

NATIONAL WATER SUPPLY

THE Society of Arts has again done useful work in bringing together a jury of experts on the question of water supply; for though the subject has engaged public attention for nearly half a century, has been investigated by Royal Commissions, and inquired into by committees appointed by scientific societies, we still find ourselves face to face with so costly and cumbersome a system of legislature, that although the country receives a rainfall which has been amply demonstrated to be far in excess of all the requirements of human consumption, manufacturing interests and purposes of canalisation, we see large districts suffering all the ills due to a polluted water-supply, whilst in other areas excessive rainfall is passing to the sea in devastating floods.

It is obvious, from a consideration of this fact, that there exists but *one* remedy for this state of things—the creation of a central authority, with power over the whole water-rights of the country for all purposes whatsoever; and upon this point there is a most striking unanimity of opinion in all the speakers attending the Society of Arts conference this year and last. Whether this authority should be placed over the whole of the 215 river basins of England and Wales, or whether they should be subdivided into groups, each presided over by separate bodies, is a question of detail, and it is necessarily one which allows of a very large amount of difference of opinion, varying with the special knowledge and tendencies of the individual propounding the scheme.

Sir Henry Cole last year suggested a division into seven districts, each under a local commission, assisted by a well-known engineer, together forming a united board, for the discussion of general questions.

Mr. Shelford pointed out that 158 river basins are contained in one county, and might be presided over by county boards, while only eleven rivers are situated in four or more counties, for which he considers special legislation would be necessary. Mr. De Rance would divide the country into six groups of river basins, Mr. Conder into ten, and he suggested the formation of a board similar to the Hydraulic Works Department in Italy, who at once take charge of the area and population of each province, the altitude of the ground, the volume of the rivers, and the amount of rainfall.

To elicit information as to the best means of dividing the country into separate watershed areas, having regard to the wants of the population and the geological and hydrological conditions, the Society of Arts offered for competition, at the Congress just held, a gold and three silver medals. No paper, it appears, has been judged of sufficient value to entitle the author to the gold medal, but two, of the seven papers selected for printing, have been thought worthy of silver medals, contributed by Mr. F. Toplis and Mr. J. Lucas. The former proposes that the country should be mapped out into watershed districts of one or more river basins, governed individually by a body of commissioners, assisted by competent legal and engineering advisers, with charge over all rivers, and power to acquire all existing water-works and canals, acting under the direction of a Minister of Health.

Mr. Lucas divides the country into northern, midland, and southern districts, with the idea of giving the commissioner presiding over each area a similar disposition of mountains and plains and constituent geological strata.

Other authorities propose still other subdivisions, and we cannot but think that the legislative creation of a numerous body of commissioners, in various districts, each with varying requirements and conflicting vested interests, would for the present only tend to increase the existing confusion; for, as we stated last year, quoting Dr. Child, "the bane of all local government in England is the chaos of different and often conflicting authorities, existing each for a special purpose." It is difficult to see how this state of things would be improved by the large powers proposed to be given to a number of new local governing bodies. For ourselves we are more inclined to agree with Capt. Douglas Galton, that all existing information should be brought to one focus, and though this information lies scattered over many departments, the Local Government Board is the legitimate focus for it; and that whether or no it is considered necessary that a Minister of Health be appointed, the preliminary step which can at once be taken is to place the heads of departments who hold information in official relation with the Local Government Board. The departments he specially referred to, being the Geological Survey, the Ordnance Survey, the Register-General's Department, and the Rainfall Committee.

The maps of the Ordnance Survey that would be most useful for hydrological purposes are those on the scale of six inches to the mile, published for the six northern counties, part of Flintshire, and for the neighbourhood of London; but unfortunately for those who have recognised the practical value of the maps on this scale, for economic purposes, the Directors of the Ordnance Survey have given priority of appearance to the larger 25-inch maps, which in addition to the objection found to their use, from the small area they include, do not contain the contour lines of equal level, which give to every 6-inch map the usefulness of a model. The Ordnance Survey are, however, bringing out a new issue, brought up to date, of their 1-inch map of England and Wales, reduced from their 25-inch map; this new 1-inch map has no hill-shading, which so often obscured the topography of the older editions, but in its place contains the principal contour lines. This map will form an admirable basis for tracing the watersheds and other hydrological purposes for which the published Ordnance Survey Catchment Basin Map is far too small.

The information collected by the Geological Survey, consists of geological maps of a large region on the scale of one inch to the mile, and of maps on the six-inch scale in the northern counties, coloured for the geological formation, and "stippled" for the superficial clays and sands with which they may be overlaid; sections across country on the six-inch scale, showing the thickness of the various permeable and impermeable formations; memoirs descriptive of districts, and including the more minute details of the strata, and particulars of the well-sections. On the latter head we would specially allude to the exhaustive detail of wells, given in the memoir of the London basin, by Mr. Whittaker, which has furnished so practical a basis for the useful investigations of Mr. Lucas, who has added to them, from personal examination, the level of the underground water in the metropolitan area.

From information supplied by Mr. De Rance to the conference, it appears that the *pervious* water-bearing formations occupy about 22,000 square miles, absorbing on an average about ten inches of rainfall a year, which, if all yielded up to wells, would give a daily average supply of 400,000 gallons per square mile, and he further shows that the larger area of these permeable formations lies east of the great water-shed, dividing England diagonally, and separating the Severn and Trent basins on the one side, from those of the Thames, east coast streams, Witham and Ouse on the other, the only important previous formation west of this boundary being the permian and new red sandstones. The latter occupies an area of 3,190 square miles.

This different disposition of the permeable and impermeable strata in England, at once explains how it is that the dry-weather flow of rivers like the Thames, draining a basin largely consisting of permeable strata, differs so remarkably in volume from rivers like the Severn, mainly occupied by impermeable silurian rocks and triassic marls, and the necessity is at once apparent of there being a *central authority*, taking cognisance of all matters bearing on water questions, and assisting parliament in giving or withholding to any corporation or district the water rights of any area to which they may lay claim. Thus, in the case of Liverpool, it is proposed to take from the sources of the Severn, a quantity of not less than 52,000,000 gallons a day, while Mr. Hawksley, in evidence before the Royal Rivers Commission, gives the driest weather flow, so low down the Severn as Tewkesbury, as only 90,000,000 gallons per day. With a margin so small, it is obvious that the maintaining of a sufficient volume of water for navigation, fisheries, and other purposes, is of national importance, and should be the subject of imperial care.

The basis of all calculations of the body of water available for gravitation purposes must of necessity be an accurate record over numerous localities of the amount of *rainfall*, and it is a matter of regret that the work carried out by Mr. G. T. Symons is not incorporated with the Meteorological Department of the Government. In 1865 the British Association appointed a Committee to assist Mr. Symons in developing the system of registration; the total number of stations now at work exceed 2,000, and the correspondence with these observers, the verification of their instruments and codification of their observations necessarily incur a large amount of expenditure. The British Association, after many years' support of the work, feeling it their duty rather to initiate than permanently subsidise investigations, have at length discontinued their grant, and the only sources with which this work of national importance to the country can be carried out by Mr. Symons are voluntary subscriptions and the profits on the annual sale of the volume of "British Rainfall." We trust that one result of the Congress may be to place this work on a more permanent and satisfactory basis, and also that the Ordnance or Geological Survey be charged with the gauging of the chief streams of the country, so that data may be furnished for really estimating what amount of rainfall at *once* runs off in impermeable districts, and how much is absorbed in permeable districts, without which all calculations as to probable yield are to a great extent hypothetical.

It is the fashion in some quarters to abuse the Local Government Board, but when it is realised that they have no authority given them by legislation to survey the country, seek out abuses, suggest and compel improvements,—until they are called to inspect often by the authorities who have allowed abuses to devastate a particular district,—we think that those who read their annual report of work will give them the greatest credit for the industry and ability with which, often at much personal discomfort, they track not only the fever-germs to their source, but confront the ignoranc and obstinacy of the small local authorities. We hoepe that the action of the Society of Arts, in bringing these matters prominently before the country may lead to the scope of the Local Government Board being so enlarged, their staff increased, and their sources of information widened, that they may become a Department of Health, ever ready not merely to find out the cause of disease, but to prevent the possibility of its occurrence. Towards this end, in rousing public opinion to the exigencies of the question, these congresses cannot be, perhaps, too highly valued. Already out of the congress held this year, a National Water Supply Exhibition has been inaugurated at the Royal Aquarium, which cannot but tend to popularise the subject, and if it should be possible to find the Exhibition a permanent home, at the South Kensington Museum, it would add an important factor to the already high educational value of that institution. Should a wider knowledge of these subjects become general, and the government legislate in the direction suggested by the Society, it will be felt that its President, the Prince of Wales, in first bringing the subject prominently before the Society, and in lately placing it before the Premier, will have been instrumental in bringing about the once almost Utopian hope of Charles Dickens, in his preface to the Pickwick Papers, that the time will come when "a few petty boards and bodies—less than drops in the great ocean of humanity which roars around them—are not for ever to loose fever and consumption on God's creatures, at their will, or always to keep their jobbing little fiddles going for a Dance of Death."

THE AUDIOMETER

ALREADY have experiments of the greatest practical value been made with the wonderful invention of Prof. Hughes described in our last number. Dr. B. W. Richardson has been applying it in two ways: as an Audiometer for the measurement of hearing, and a Sphygmophone for measuring the pulse. Both applications were described at the last meeting of the Royal Society.

The audiometer, as it had been used, was shown to the Society. It consists of two Leclanché's cells for the battery, a new and simple microphonic key connected with the cells and with two fixed primary coils, and a secondary or induction coil, the terminals of which are attached to a telephone. The induction coil moves on a bar between the two fixed coils, and the bar is graduated into 200 parts, by which the readings of sound are taken. The graduated scale is divided into 20 centims., and each of these parts is subdivided into 10, so that the hearing may be tested from the maximum of 200 units to 0°—zero. The fixed coil on the right hand contains 6 metres of wire; the fixed coil on the left hand contains 100 metres. By this means a long scale from the left hand coil is produced. The secondary coil contains 100 metres of wire.

In using the instrument, the induction coil is moved along the scale from or towards the larger primary, as may be required, and the degrees or units of sound are read from the figures on the scale, the sound being made by the movement of the microphonic key between the battery and the primary coils.

The instrument may be considered to afford the most satisfactory means for testing the hearing power of all persons who can define a sound. The range of sound is sufficient at the maximum—200°—for every one who is not absolutely deaf; 0°, or zero, is a point of positive silence from the instrument, or rather from the sound which it produces through the telephone.

One of the first facts learned with the audiometer is the suddenness with which the sound is lost to those who are listening. The sound is abruptly lost within a range of 2°; that is, within one-hundredth part of the entire scale. This is the case with those who are very deaf as well as with those who hear readily.

In testing the capacity of hearing, it is noticeable that the power to detect the diminishing sound is maintained best by continuing the reduction in trace or line while the attention is fixed. A sudden break may cause the sound to be lost to the listener long before his real incapacity to hear is reached. If, for instance, the sound be very faintly heard at 15°, and the induction coil be suddenly moved to 5°, the sound at 5° may be quite inaudible; but if the coil be slowly moved, unit by unit, from 15° to 5°, the sound at 5° may be distinctly heard.

The effect of filling the chest and holding the breath makes a difference in listeners. The capacity for hearing is for a few seconds increased by holding the breath. Holding the breath with the chest not full fails to produce the same result.

As a rule, the hearing of persons who are right-handed is most refined in the right ear, and as most persons are right-handed, it is found that the right ear is the best ear. This rule is, however, attended with many exceptions, since, for various reasons, some persons who use the right hand exclusively, practise for some particular purpose the use of the left ear, upon which that ear becomes more acute. Another point of interest attaching to this observation is, that the practice of using one ear for special refinement of the sense seems for the time slightly to impair the other ear, although there is no physical evidence of such impairment.

Connected with the last-named fact is another, namely, that by this instrument the deaf are found to fail in capacity of hearing not only by reason of physical defect, but also by failure of memory of sounds. Thus in a youth who had suffered serious defect of hearing for seven years, owing to partial destruction of the tympanum, and who in the right ear could only detect sound at 107°, there was an inability to catch all the sound lying between 130° and 107°, until he could remember what he had to listen for. By practising him then to detect the lowest sound that he was physically capable of receiving, Dr. Richardson got him to detect this one sound more readily than those which came higher up. By further practice all the intervening sounds became audible with equal facility.

By use of the audiometer the influence of atmospheric pressure on hearing is detectable. In Dr. Richardson's own case, when the barometer is at 30° he can hear on both sides close down to zero; but below 30° he fails by 2° on the left side to reach zero. In another person a similar failure extends to a loss of 4°.

Dr. Richardson has tried to determine in some of the lower animals whether there is the same sense of hearing as in man. In two dogs, one a terrier, the other a field spaniel, the range of hearing power seemed to be distinctly lower than it is in the human subject who has perfect hearing. In both these animals, which were healthy, and in the prime of life, the first indication of the detection of sound commenced at 10° on the scale.

Dr. Richardson's practical conclusions are—

1. The audiometer will, he thinks, be an essential in all physical examinations of men who are undergoing examination as to their fitness for special services requiring perfect hearing, such as soldiers, sentries, railway officials, and the like. 2. The instrument will be of great use to the physician in determining the value of hearing in those who are deaf, and in determining the relative values of the two organs of hearing. 3. In other forms of diagnosis he has found the instrument useful, as in anæmia and vertigo. 4. The instrument may be used to differentiate between deafness through the external ear and deafness from closure of the Eustachian tube—throat deafness. 5. The instrument promises to be very useful in detecting the effects in the body of those agents which quicken or excite the circulation, such as alcohol and other similar chemical substances. 6. The instrument promises to be of great service in determining the value of artificial tympanums in instances of deafness due to imperfection or destruction of the natural tympanum. Dr. Richardson finds in fine gold the substance for making the most useful and effective artificial drum.

The sphygmophone, for obtaining a secondary or telephonic sound from the movements of the pulse at the wrist, is devised by adding a microphone to a Pond's sphygmograph. Dr. Richardson mounts on a slip of talc, glass, or wood a thin plate of platinum or gas carbon. He places the slip in the sphygmograph as if about to take a tracing of the pulse. One terminal from a Leclanche's cell is connected to the platinum or carbon, and the second terminal from the cell to a terminal of the telephone, the other terminal of the telephone with the metal rod of the sphygmograph which supports the slip. The instrument is placed on the pulse, in the ordinary way, and is adjusted, with the writing needle thrown back, until a good pulsating movement of the needle is secured. The needle, in passing over the metallic plate, causes a distinct series of sounds from the telephone, which correspond with the movements of the pulse. The sounds are singular, as resembling the two words, "bother it." The sounds can be made very loud by increasing the battery power.

In this connection we may state that in the last number of *La Nature* a micro-telephonic explorer is described, also evidently of great use in pathology. This is a simple instrument, devised by MM. Charden and Prayer, consisting of a telephonic apparatus with microphonic intermediary to intensify any sounds sought for, and which, among other purposes, will be of great service in detecting any foreign body in a vital organ. The apparatus is quite portable and worked with comparative ease, though doubtless actual practice will suggest improvements both in this and in the applications devised by Dr. Richardson.

A MACHINE FOR DRAWING COMPOUND HARMONIC CURVES[1]

HARMONIC curves possess great importance, since they represent to the eye the circumstances of motion of bodies in a state of vibration, and hence apply not merely to the pendulum and to musical instruments when giving their tones, but also to the particles of air during the transmission of sound.

The study of these curves offers us two problems of almost equal importance and interest, viz.: First, Given the curve; required, to find its component simple elements. Second, Given the component simple curves; required, to construct the resulting compound curve. From the standpoint of acoustics these problems may be stated thus: First, Given a complex sound, required to find the simple musical tones of which it is composed. Second, Given the intensity, pitch, and phase of each of a number of pure musical tones; required, to find the effect of their simultaneous action on the air.

The laborious investigations of Donders, Helmholtz, and others into the constitution of the simplest elements of speech—the vowel sounds—show that the actual analysis of the simplest articulate sound is no easy matter. When the curve corresponding to the sound is once obtained, Fourier's theorem enables us to subject it to mathematical analysis, and thus determine by a somewhat laborious process, its simple harmonic elements. Three methods give us such curves. König[2] employed two tuning-forks, to actually draw the curve belonging to their combination; this method is limited to combination of two simple tones. Messrs. Jenkin and Ewing[3] magnified the impression made on the tin-foil of the *phonograph*, obtaining thus the curve belonging to the sound impressed on the vibrating disk.

[1] Abstract of Paper in the *American Journal of Otology* for April, by Prof. E. W. Blake, Brown University.
[2] *Poggendorff's Annalen*, Bd. clvii. S. 177, 1876.
[3] NATURE, May 9, 1878; July 25, 1878.

A third method[1] is the photographing of the vibrations of a disk set in vibration by the sound to be analysed. The curves are drawn with great sharpness and seem to offer the best means for pursuing this investigation. It was the study of these photographs which led Prof. Blake to consult with Prof. H. A. Newton, of Yale College, on the possibility of producing similar curves by mechanical means. Prof. Donkin, F.R.S., had described a machine by which the combination of any *two* simple tones could be drawn,[2] but the apparatus was not available for more complex combinations. The machine now to be described was the result of this consultation.

Fig. 1 represents the machine. A, A^{i}, A^{ii}, A^{iii}, A^{iv}, A^{v}, are T-shaped pieces of sheet brass, sliding between screws, motion being given to each by a crank-pin entering a slot cut in the cross-bar of the T. Each crank is driven by a pulley which is set in revolution by a string passing completely around it. The wheel B serves to return the string to the tightening pulley, D, which gives or takes up the "slack" when the crank-pulleys are changed. Firmly attached to B, and revolving on the same axle, is a smaller wheel which drives the roller feeding the paper on which the curves are traced. To secure the necessary tightening of the second string, the axle of B is inserted in the end of a wooden bar which slides horizontally under the frame. The strain given by D having tightened the string sufficiently, this bar is clamped by the thumb-nut, F.

The driving roller, G, is covered with sand-paper, and the pressure of the companion roller, H, secures the feed of the paper between them. A small brass wheel, C, is pressed by the spring of its steel axle on the middle of the paper strip. It has a sharp edge, and prevents lateral motion of the paper liable to result from friction of the pencils.

E, E^{i}, E^{ii}, are strips of brass sliding between screws. Each has a steel spring attached to it, to the end of which a thick piece of brass is soldered. A hole through this brass is tapped with a screw thread, into which the pencils (or tubular pens) fit and are readily adjusted to the desired height. E, E^{i}, and E^{ii}, have each a steel pin projecting upward from their middle points. Similar pins project from points near the ends of A, A^{i}, A^{ii}, &c.

A cross-bar connects the pins A^{i}, E^{ii}, and A^{ii}, the joint at E^{ii} admitting simply of revolution, while at A^{i} and A^{ii} there are slots in the bar permitting both rotation and sliding. A^{iii}, A^{iv}, and E, are similarly connected. A third cross-bar connects E and E^{ii} with E^{i}, having slots at E and E^{ii}, and a simple rotary joint at E^{i}.

A is not represented as in action, in order not to complicate the drawing and description unnecessarily. It would be connected by a cross-bar with E^{i}, and a fourth slider (E^{iii}) placed midway between A and E^{i}.

The operation is as follows:—Imagine a strip of paper fed between the rollers and passing under the pencils. The pulleys revolve by the action of the string, and their cranks give the respective T's movements which are the rectilinear components of the circular movements of the crank-pins. A pencil attached *directly* to any one of the T-s, would therefore draw on the paper a simple harmonic curve,[3] whose "period" depends on the diameter of the pulley, and whose amplitude depends on the length of the crank-arm. The connection of the cross-bars with E and E^{ii}, compels these strips to perform movements which are respectively *one-half* those of $A^{iv} + A^{iii}$, and $A^{ii} + A^{i}$. Hence, from the pencil in E, we get a curve combining A^{iv} and A^{iii}, but having ordinates of one-half their sum; from the pencil in E^{ii}, a curve combining A^{ii} and A^{i}, in like manner. Finally, the cross-bar connecting E and E^{ii} determines a movement of E^{i} which is *one-fourth* the sum of the movements of the four T-s, and, therefore, E^{i} describes upon the paper the curve belonging to the chosen relations of "period," "amplitude," and "phase."

The relations of these three terms may be varied to any extent (within practical limits), and with great ease. The accuracy with which a definite period may be obtained without the use of gearing, is quite surprising.

Specimens of the curves obtained are given in Fig. 2.

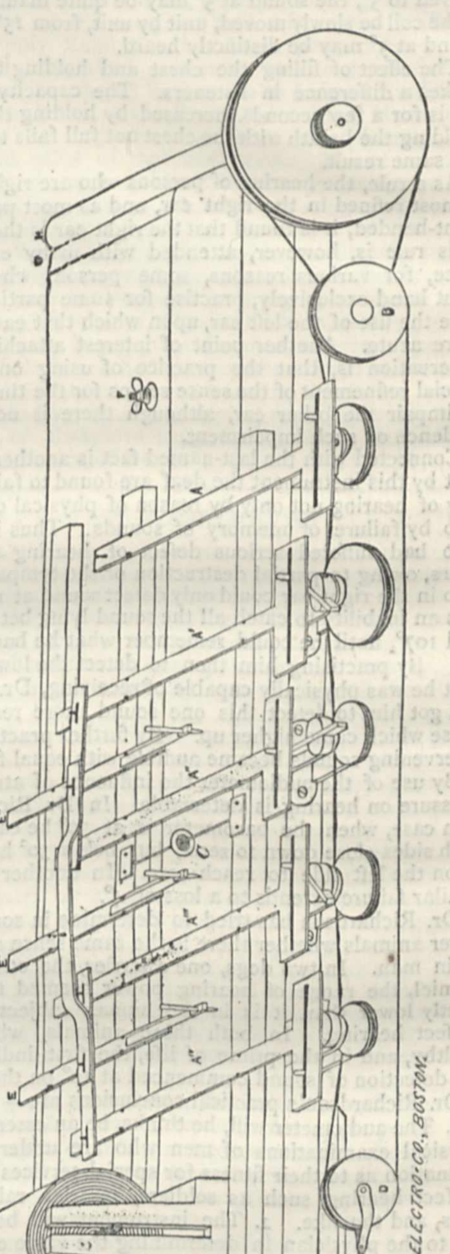


Fig. 1.

Nos. 1 to 8 (inclusive) are combinations of the first four terms of the Harmonic Series:—

Ratios of vibration	1 :	2 :	3 :	4.
Amplitudes of vibration	1	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$.

[1] *Silliman's American Journal*, vol. xvi., 3rd Series, July, 1878. NATURE, July 25, 1878.
[2] Royal Society *Proceedings*, xxii. p. 196. British Association *Reports*, 1873, xliii. p. 65.
[3] This method of drawing simple harmonic curves is due to Prof. E. C. Pickering. See *Journal*, Franklin Institute, vol. lvii. p. 55.

No. 1. All four tones in the same phase when starting.
,, 2. Tone 1 advanced $\frac{1}{4}$ vibration when starting.
,, 3. ,, 2 ,, ,, ,, ,,
,, 4. ,, 3 ,, ,, ,, ,,
,, 5. ,, 4 ,, ,, ,, ,,
,, 5*a*. ,, 1 ,, $\frac{1}{8}$,, ,,
,, 6. ,, 2 ,, ,, ,, ,,
,, 7. ,, 3 ,, ,, ,, ,,
,, 8. ,, 4 ,, ,, ,, ,,

Nos. 9 to 18 (inclusive) are combinations of the first three *odd* terms of the Harmonic Series :—

Ratios of vibration ... ... 1 : 3 : 5.
Amplitudes of vibration ... ... 1 $\frac{1}{3}$ $\frac{1}{5}$.

No. 9. All three tones in the same phase when starting.
,, 10. Tone 1 advanced $\frac{1}{8}$ vibration when starting.
,, 11. ,, ,, ,, $\frac{1}{4}$,, ,,
,, 12. ,, ,, ,, $\frac{3}{8}$,, ,,

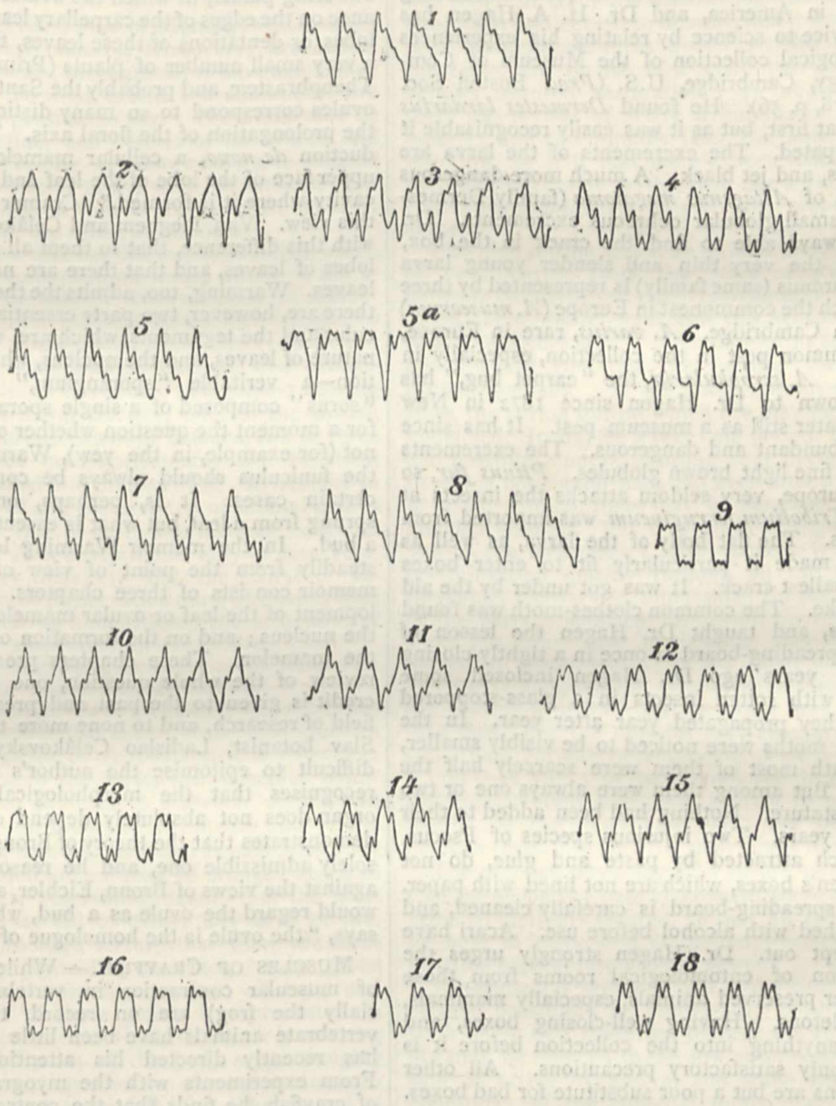


Fig. 2.

No. 13. Tone 3 advanced $\frac{1}{8}$ vibration when starting.
,, 14. ,, ,, ,, $\frac{1}{4}$,, ,,
,, 15. ,, ,, ,, $\frac{3}{8}$,, ,,
,, 16. ,, 5 ,, $\frac{1}{8}$,, ,,
,, 17. ,, ,, ,, $\frac{1}{4}$,, ,,
,, 18. ,, ,, ,, $\frac{3}{8}$,, ,,

Nos. 19 and 20 are combinations from the Diatonic Scale.
No. 19 shows the Common Chord, *Major* :—

Ratios of vibration ... ... 1 : $\frac{5}{4}$: $\frac{3}{2}$.

No. 20 shows the Common Chord, *Minor* :—

Ratio of vibration ... ... 1 : $\frac{6}{5}$: $\frac{3}{2}$.

In both the intensities of the component tones are equal, and their phases at starting identical.

BIOLOGICAL NOTES

MUSEUM PESTS IN ENTOMOLOGICAL COLLECTIONS.—Every record of successful contests with destroying agencies in museums will be of interest to collectors, and useful hints as well as valuable data in natural history may be derived from accounts of the animal species which appear in museums in widely separated localities. Very little information is as yet in print concerning museum pests in America, and Dr. H. A. Hagen has rendered a service to science by relating his experiences in the entomological collection of the Museum of Comparative Zoology, Cambridge, U.S. (*Proc.* Boston Soc. Nat. Hist., 1878, p. 56). He found *Dermestes lardarius* very abundant at first, but as it was easily recognisable it was soon extirpated. The excrements of the larva are large, granulous, and jet black. A much more dangerous foe is the larva of *Attagenus megatoma* (family Dermestidæ), having small globular ochreous excrements. Dr. Hagen was always able to find the crack in the box, through which the very thin and slender young larva entered. Anthrenus (same family) is represented by three species, of which the commonest in Europe (*A. museorum*) is very rare in Cambridge. *A. varius*, rare in Europe, is the most common pest in the collection, especially in new additions. *A. scrophulariæ*, the "carpet bug," has only been known to Dr. Hagen since 1872 in New England, and later still as a museum pest. It has since become very abundant and dangerous. The excrements consist of very fine light brown globules. *Ptinus fur*, so common in Europe, very seldom attacks the insects at Cambridge. *Tribolium ferrugineum* was imported from the East Indies. The flat body of the larva, as well as of the beetle, made it particularly fit to enter boxes through the smallest crack. It was got under by the aid of tobacco-smoke. The common clothes-moth was found very dangerous, and taught Dr. Hagen the lesson of placing every spreading-board at once in a tightly-closing box. Several years ago Dr. Hagen inclosed some clothes-moths with rotten insects in a glass-stoppered bottle, where they propagated year after year. In the fourth year the moths were noticed to be visibly smaller, and in the sixth most of them were scarcely half the ordinary size. But among them were always one or two of the normal stature. Nothing had been added to their food in these years. Two injurious species of Psocus, which are much attracted by paste and glue, do not infest Dr. Hagen's boxes, which are not lined with paper. Further, every spreading-board is carefully cleaned, and the cracks washed with alcohol before use. Acari have been easily kept out. Dr. Hagen strongly urges the entire separation of entomological rooms from those containing other preserved animals, especially mammals, birds, and skeletons. Having well-closing boxes, and never putting anything into the collection before it is safe, are the only satisfactory precautions. All other recommendations are but a poor substitute for bad boxes.

EFFECT OF LIGHT ON PELOMYXA.—In a very low, amœba-like organism, *Pelomyxa palustris*, Herr Engelmann recently observed a remarkable action from sudden incidence of a moderate light (Pflüger's *Archiv für Physiologie*, Bd. xix. p. 1). Watched in the microscope this organism showed very slow movements, which, however, on shading the object, became much more lively. When the hand was removed, the granular mass in the interior became still, and the body contracted into a ball, as after an electric shock; this effect occurred within a few seconds. With continued moderate light, weak changes of form appeared again, with hardly perceptible locomotion. This experiment was several times repeated with equal success, and the results were especially notable in a dark room, into which diffuse daylight could be admitted. When, however, the room was illuminated, not suddenly, but gradually, the pelomyxa showed no effect.

THE OVULE.—One of the most important of the recent contributions to the embryology of plants is, without question, Prof. Warming's memoir, "De l'Ovule" (*Annales des Scien. Nat.* sixe sér., Bot., tome v.). Commencing with a sketch of the views as to the origin of the ovule and nucleus, held in 1844 by Ad. Brongniart, which is in brief, "that there are two different origins for the ovule, the one to be found in the immense majority of flowering plants, in which the ovules make their appearance on the edges of the carpellary leaves, and represent the lobes or dentations of these leaves, the other confined to a very small number of plants (Primulaceæ, Myrsinaceæ, Theophrasteæ, and probably the Santalaceæ), in which the ovules correspond to so many distinct leaves carried on the prolongation of the floral axis. The nucleus is a production *de novo*, a cellular mamelon developed on the upper face of the lobe of the leaf and in the bottom of the cavity where it is formed." Cramer admits and confirms this view. Van Tieghem and Celâkovsky also agree to it, with this difference, that to them all the ovules appear as lobes of leaves, and that there are no independent ovular leaves. Warming, too, admits the theory. In every ovule there are, however, two parts essentially different, the funiculus and the teguments, which are, without doubt, of the nature of leaves, and the nucleus, which is a "new" creation—a veritable "sporangium," as Prantl says, a "sorus" composed of a single sporangium. Discarding for a moment the question whether ovular leaves exist or not (for example, in the yew), Warming doubts whether the funiculus should always be considered as foliar in certain cases. It is, perhaps, only a metablastome sprung from a leaf, but what is essential is that it is never a bud. In the memoir Warming looks at the question steadily from the point of view of histogenesis. The memoir consists of three chapters. On the early development of the leaf or ovular mamelon; on the genesis of the nucleus; and on the formation of the integuments of the mamelon. These chapters present a most masterly review of the whole question, one in which every due credit is given to the past and present workers in this field of research, and to none more than to the ingenious Slav botanist, Ladislao Celâkovsky. It is somewhat difficult to epitomise the author's conclusions, but he recognises that the morphological significance of an organ does not absolutely depend on its position. He demonstrates that the theory of Brongniart is the true and solely admissible one, and he reasons very conclusively against the views of Bronn, Eichler, and Strasburger, who would regard the ovule as a bud, while, in reality, as he says, "the ovule is the homologue of a sporangium."

MUSCLES OF CRAYFISH.—While many observations of muscular contraction in vertebrate animals (especially the frog) are on record, the muscles of invertebrate animals have been little studied. M. Richet has recently directed his attention to these latter. From experiments with the myograph on the muscles of crayfish, he finds that the contraction of the muscle of a claw lasts nearly ten times as long as that of the caudal muscle (80 to 100 stimulations per second were needed to cause tetanus in the tail, while 2 to 4 sufficed for the claw). The contraction was not more retarded in one muscle than the other; with strong direct excitations, it is about a hundredth of a second; with weak it may be four or five hundredths. With the former stimulations applied to the ganglionic chain instead of directly, the total retardation is about 2·5 hundredths of a second. The muscle of the tail is very quickly exhausted, and this agrees with the fact that crayfish cannot swim any great distances. On the other hand, the muscle of a claw, stimulated by very closely following electric currents, is not exhausted. While the tetanus of the caudal muscle does not last more than twenty to thirty seconds, the muscle of the claw remains contracted nearly half an hour, and during the first five minutes the constriction of the claw is stronger and stronger. This, too, accords with the habits of the crayfish, which will almost sooner die than let go its prey when seized. Thus between the two chief muscles of the crayfish there is a difference at least as considerable as between the striated and non-striated muscles of vertebrates.

SUSPENDED ANIMATION

THE statements in the *Times* of Monday, which, under the head of "A Wonderful Discovery," are copied from the *Brisbane Courier*, seem greatly to have astonished the reading public. To what extent the statements are true or untrue it is impossible to say. The whole may be a cleverly-written fiction, and certain of the words and names used seem, according to some readers, to suggest that view; but be this so or not, I wish to indicate that some part, at all events, of what is stated might be true, and is certainly within the range of possibility.

At once let me state that the discovery, so called, which is described in the communication under notice, is not in principle new. On the subject of suspension of animation I have myself been making experimental inquiries for twenty-five years at least, and have communicated to the scientific world many essays, lectures, and demonstrations relating to it. I have twice read papers bearing on this inquiry to the Royal Society, once to the British Association for the Advancement of Science, two or three times in my lectures on Experimental and Practical Medicine, and published one in NATURE. In respect to the particular point of the preservation of animal bodies for food, I dwelt on this topic in the lectures delivered before the Society of Arts in April and May of last year, 1878, explaining very definitely that the course of research in the direction of preservation must ultimately lead to a process by which we should keep the structures of animals in a form of suspended molecular life.

Let me next point out what, by experiment, is known as to the possibility of suspending animal life.

If an animal perfectly free from disease be subjected to the action of some chemical agents or physical agencies which have the property of reducing to the extremest limit the motor forces of the body, the muscular irritability, and the nervous stimulus to muscular action, and if the suspension of the muscular irritability and of the nervous excitation be made at once and equally, the body even of a warm-blooded animal may be brought down to a condition so closely resembling death, that the most careful examination may fail to detect any signs of life. I have shown in a Croonian lecture that there are three degrees of muscular irritability to which I have given the names of active efficient, passive efficient, and negative. The first of these states is represented in the ordinary living muscle in which the heart is working at full tension, and all parts of the body are thoroughly supplied with blood, with perfection of consciousness in waking hours, and, in a word, full life. The second of these states is represented in suspended animation, in which the heart is working regularly, but at low tension, supplying the muscles and other parts with sufficient blood to sustain the molecular life, but no more. The third of these states is represented when there is no motion whatever of blood through the body, as in an animal entirely frozen.

The second stage, the stage of passive efficiency, is that in which animation is usually suspended. The condition is a close semblance to the third stage, but differs from it in that under favouring circumstances the whole of the phenomena of the active efficient stage may be perfectly resumed, the heart suddenly enlarging in volume, from its filling with blood, and reanimating the whole organism by the force of its renewed stroke, in full tension.

So far as we have yet proceeded, the whole phenomena of restoration from death are accomplished during this stage. To those who are not accustomed to see them, they are no doubt very wonderful, looking like veritable restorations from death. They surprise even medical men the first time they are witnessed by them.

At the meeting of the British Medical Association at Leeds, a member of the Association was showing to a large audience the action of nitrous oxide gas, using a rabbit as the subject of his demonstration. The animal was removed from the narcotising chamber a little too late, for it had ceased to breathe, and it was placed on the table, to all appearances dead. At this stage I went to the table, and by use of a small pair of double-acting bellows restored respiration. In about four minutes there was revival of active irritability in the abdominal muscles, and two minutes later the animal leaped again into life, as if it had merely been asleep. There was nothing remarkable in the fact, but it excited, even in so cultivated an audience as was then present, the liveliest surprise.

The time during which an animal body may be capable of re-animation from the state of passive efficiency depends altogether on one circumstance, viz., whether the blood, the muscular fluid, and the nervous fluid remain, in a condition which I have defined in another essay as the aqueous condition, or whether these fluids have become pectous. If the fluids remain in the aqueous state, the period during which life may be restored is left undefined. It may be a very long period, including weeks, and possibly months, granting that decomposition of the tissues is not established, and even after a limited process of decomposition, there may be renewal of life in cold-blooded animals. But if pectous change begins in any one of the structures I have named, it extends like a crystallisation quickly through all the structures, and thereupon recovery is impossible, for the change in one of the parts is sufficient to prevent the restoration of all. Thus the heart may be beating, but the blood being pectous it beats in vain; or the heart may beat and the blood may flow, but the voluntary muscles being pectous, the beating is in vain; or the heart may beat, the blood may flow, and the muscles may remain in the aqueous condition, but the nerves being pectous the circulating action is in vain; or sometimes the heart may come to rest and the other parts may remain susceptible, but the motion of the heart and blood not being present to quicken them into activity, their life is in vain.

The problem physiologically before us is as follows:—Can the second or passive efficient stage of life be by any artificial methods secured, so that all the vital parts may be held in suspended animation, working at the lowest possible expenditure of vital power?

Experimental research and experience alike show the certain possibility of temporarily producing this state. Both show that there are agents and agencies by which life may be reduced to the low ebb necessary for suspension of active life, and at the same time the aqueous conditions of the colloidal fluids may be maintained. Cold is the first and most efficient of these agencies. The blood and the colloidal animal fluids derived from it are all held in the aqueous condition of colloidal matter by exposure to cold at freezing-point. At this same point all vital acts, excepting, perhaps, the motion of the heart, may be temporarily arrested in an animal, and then some animals may continue apparently dead for long intervals of time, and may yet return to life under conditions favourable to recovery.

In one of my lectures on death from cold, which I delivered in the winter session of 1867, some fish, which, during a hard frost, had been frozen in a tank at Newcastle-on-Tyne, were sent up to me by rail. They were produced in the completely frozen state at the lecture, and by careful thawing many of them were restored to perfect life. At my Croonian lecture on muscular irritability after systemic death, a similar fact was illustrated from frogs.

There seems in cold-blooded animals so circumstanced to be no recognisable limit of time after which they may not recover, but there is much skill required in promoting the recovery. If in thawing them the utmost care be not taken to thaw gradually, and at a temperature always below the natural living temperature of the animal, the fluids of the animal will pass from the frozen state through the aqueous into the pectous so rapidly that death from pectous change will be pronounced without perceiving any intermediate or life-stage at all. In warm-blooded animals it is extremely difficult to restore animation after suspension of life by cold, owing to the fact that in their more complex and differently-shielded organs, it is next to impossible to thaw equally and simultaneously all the colloidal fluids. In very young animals it can be done. Young kittens, a day or two old, that have been drowned in ice cold water, will recover after two hours' immersion almost to a certainty, if brought into a dry air at a temperature of 98° F. The gentlest motion of the body will be sufficient to re-start the respiration and therewith the life.

The nearest approach we see naturally to this state is in hybernating animals. In them the effects of cold in the season for hybernation and the recovery from the torpor are seen even in matured and old animals. In hybernation, however, there is not produced the complete stage of passive efficiency. There is in them a slow respiration and a low stage of active efficiency of circulation. The hybernating animal sleeps only; and while sleeping it consumes or wastes, and, if the cold be prolonged, it may die from wasting. From the sleep of hybernation also the animal can be roused by the common methods used for waking a sleeper, so that animation is not positively suspended.

Returning to the extreme effects of cold on animal bodies, it is hard to say whether an animal like a fish, frozen equally through all its structures, is actually dead, in the strict sense of the word, seeing that if it be uniformly and equally thawed it may recover from a perfect glacial state. In like manner it may be doubted whether a healthy warm-blooded animal, suddenly and equally frozen through all its parts, is dead, although it is not recoverable, because, in the very act of trying to restore it, some inequality in the direction is almost sure to determine a fatal issue owing to the transition of some vital centre into the pectous state of colloidal matter. I do not, consequently, see that cold can be of itself and alone utilized for maintaining suspended animation in the larger warm-blooded animals of full growth. At the same time cold will, for a long time, maintain, ready for motion, active organs locally subjected to it. Even after death this effect of it may be locally demonstrated, and has sometimes been so demonstrated to the wonder of the world. On January 17, in the year 1803, Aldini, the nephew of Galvani, created the greatest astonishment in London by a series of experiments which he conducted on a malefactor, twenty-six years old, named John Forster, who was executed at Newgate, and whose body, an hour after execution, was delivered over to Mr. Keate, Master of the College of Surgeons, for research. The body had been exposed for an hour to an atmosphere two degrees below freezing-point, and from that cause, though Aldini does not seem to have recognized the fact, the voluntary muscles retained their irritability to such a degree that when Aldini began to pass voltaic currents through the body some of the bystanders seem to have concluded that the unfortunate malefactor had come again to life. It is significant also that Aldini, in his report, says that his object was not to produce re-animation, but to obtain a practical knowledge how far galvanism might be employed as an auxiliary to revive persons who were accidently suffocated, as though he himself were in some doubt.

In repeating Aldini's experiments on lower animals that had passed into death under chloroform, with the view of determining what is the best treatment for those human beings who sink under chloroform and other anæsthetics, I failed altogether to obtain the same results when the temperature of the day was high. Noticing this, I experimented at or below freezing-point, and then found that both by the electrical discharge and by injection of water heated to 130° F. into the muscles through the arteries, active muscular movements could be produced in warm-blooded animals many hours after death. Thus, for lecture experiment I have removed one muscle from the body of an animal that had slept to death from chloroform, and, putting the muscle in a glass tube surrounded with ice and salt, I have kept it for several days in a condition for its making a final muscular contraction, and, by gently thawing it, have made it, in the act of final contraction, do some mechanical work, such as moving a long needle balanced on the face of a dial, or discharging a pistol.

In muscles so removed from the body and preserved ready for motion, there is, however, only one final act. For, as the blood and nervous supply are both cut off from it, there is nothing left in it but the reserve something that was fixed by the cold; but I do not see any reason why this should not be maintained in reservation for weeks or months, as easily as for days, in a fixed cold atmosphere.

Besides cold there are other agencies which hold the colloidal fluids in the aqueous state, and which, while they suspend the motor function, suspend without necessarily destroying life. Several agents of this class have been discovered.

Mandragora.—The first known of these suspending agents was mandragora. This was known as far back as Dioscorides. Dioscorides states that this vegetable substance may be administered in such a manner that the signs of active life may disappear, and sensibility be so far destroyed that the physician or surgeon may operate on the temporarily insensible without producing pain. The suspension of life from mandragora may extend over some hours, and the use of the agent probably was continued until the twelfth or thirteenth century. From the action of it doubtless comes the Shakespearian legend of Juliet. In modern times I have made the wine of mandragora, and found that it has the power originally attributed to it of suspending without destroying active life. The wine from it was the morion of the ancients, the fluid probably that was used by the Jewish women in the times of the Sanhedrim to destroy the sufferings of those who were under torture, and sometimes, perchance, to deceive the executioner and prevent the deadliness of his task.

The plant from which morion was originally made, the *Atropa belladonna* (deadly nightshade), has, in this country, similar properties to its ally the *Atropa mandragora*. In 1851 I attended at Mortlake two children who were poisoned for a time from eating the berries and chewing the leaves of the nightshade which they had gathered near to Richmond. The children were brought home insensible, and they lay in a condition of suspended life for seven hours, the greatest care being required to detect either the respiration or the movements of the heart. They nevertheless recovered.

Nitrite of Amyl.—In my original researches on the nitrite of amyl, one of the observations which most surprised me was the power of this agent to suspend animation. In the report I made to the British Association in 1864 on this subject, I showed that the life of the frog might be suspended for the period of nine days, and yet recovery to full and vigorous life might follow; that the same power of suspension, in a lesser degree, could be produced in warm-blooded animals, and that the heart of a warm-blooded animal would contract for the period of eighteen hours after apparent death. The action of the nitrite of amyl in causing suspended animation seemed to be like cold. It prevented the pectous change of colloidal matter, and so prevented rigor mortis, coagulation of blood, and solidification of nervous centres and cords. So long as this change was suspended return of vital function was possible. When the pectous change occurred, all was over, and resolution into new forms of matter by putrefaction was the result.

From the analogy of some of these symptoms from nitrite of amyl with the symptoms of the disease called catalepsy, I have ventured to suggest that, under some abnormal conditions, the human body itself, in its own chemistry, may produce an agent which causes the suspended life observed during the cataleptic condition.

Woorali in a similar manner suspends vital function; but as the influence of this agent has been more frequently under observation from other physiologists, I leave it with this mention of it.

Chloral Hydrate has many of the properties of the other substances named above in its power of suspending life. At the meeting of the British Association at Exeter, at which I made the earliest report in this country of Liebreich's remarkable discoveries, some pigeons, which had been put to sleep by the needle-injection of a large dose of chloral, fell into such complete resemblance of death, that they passed among an audience containing many physiologists and other men of science for dead. For my own part I could detect no sign of life in them, and they were laid in one of the out-offices of the museum of the infirmary as dead. In this condition they were left late at night, but in the following morning they were found alive and as well as if nothing hurtful had happened to them.

Cyanogens.—Cyanogen gas and hydrocyanic acid, deadly poisons as they are, have the power in a singular degree of suspending animation. Combined with a sufficient degree of cold to prevent their evaporation from the body, their suspending power is of the most definite kind. In the laboratory of a large drug establishment a cat, by request of its owner, was killed, as it was assumed, instantaneously and painlessly by a large dose of Scheele's acid. The animal appeared to die without a pang, and presenting every appearance of death was laid in a sink to be removed on the next morning. At night the animal was lying still in form of death in the tank beneath a tap. In the morning it was found alive and well, but with the fur wet from the dropping of water from the tap. This fact was communicated to me by the eminent chemist under whose direct observation it occurred, in corroboration of an observation of mine similar in character.

Alcohol is another substance which holds the vital functions in suspense for long periods of time, the muscles retaining their excitability. In animals killed by alcohol in combination with cold, two influences which act powerfully together in the same direction, I found the muscular excitability could be retained at freezing-point for several hours even in birds. A remarkable similar experience, which I have elsewhere recorded, was obtained in the case of an intoxicated man who, while on the ice at the Welsh Harp lake, fell into the water through a breakage in the ice, and who for more than fifteen minutes was completely immersed. This man was extricated to all appearances dead, but under artificial respiration, carried out by my friend Dr. Belgrave, of Hendon, he was restored to consciousness and lived for several hours.

Oxygen.—It is not a little singular that pure oxygen gas possesses the power of suspending life, at all events in muscular fibre, when it is aided by condensation produced by cold; but I am on new ground here, with which I am not so conversant at present as I hope to be.

I have now shown as briefly as was possible that much is known in the world of science in respect to suspension of animal life by artificial means. It will be seen that cold as well as various chemical agents has this power; and it is worthy of note that cold, together with the agents named, is antiseptic, as though whatever suspended living action, suspended also by some necessity or correlative influence the process of putrefactive change. Hence the influence I drew in my lecture at the Society of Arts, that it was within the range of experiment to preserve the structures of dead animals in a form of suspended molecular life.

If the experiments reported from Brisbane be reliable it is clear, I think, that what has been done has been effected by the combination of one of the chemical agents above named, or of a similar agent, in combination with cold, the efficiency of which combination we have seen in many of the experimental facts referred to above. The only question that exists as of moment is, not whether a new principle has been developed, but whether, in matter of detail, a new product has been discovered which, better than any of the agents we already possess, destroys and suspends animation. In organic chemistry, there are, I doubt not, hundreds of substances which, like mandragora and nitrite of amyl, would suspend the vital process, and it may be that a new experimenter has met with such an agent. It is not incredible indeed that the Indian Fakirs possess a vegetable extract or essence which possesses the same power, and by means of which they perform their as yet unexplained feat of prolonged living burial: but I confess, on reading the Australian narrative, there is nothing suggested by it to my mind that might not be produced by agents already known. Making allowance for what is clearly a very enthusiastic description, there is nothing in an experiment related as made on a dog that might not have been produced by the subcutaneous injection of hydrate of chloral; neither is there anything in other experiments that might not follow from the injection of chloral or woorali in a cold atmosphere. At the same time it is not also unreasonable to infer that a new product has been found which surpasses any we possess, and suspends animation for a longer period. My faith is most shaken first by the statement that the agent referred to is a secret, for men of true science know no such word; secondly, that the experimenter has himself to go to America to procure more supplies of his agents; and thirdly, that he requires two agents, one of which is antidotal to the other. I can understand the production of a definite effect from a single; and others as well as myself have made out a great many facts respecting the antagonism of one agent by another. But in our researches on antagonistic physiological substances we require the agencies of absorption and circulation of the antidote, and how in a body bereft of motion and practically dead such absorption can take place I am unable to divine.

But even should the description given by the Australian journalist prove overdrawn or imaginative, I am not sorry it has appeared, since it has afforded a reason for relating in a plain and faithful manner to what actual extent human knowledge has been advanced by experiment on the subject under consideration. This duty, though it be but preliminary, is important as an introduction to those great events which in the future are sure to come from the positive results that have already been secured, and for which the world should be prepared, without anxiety or amazement.

BENJAMIN WARD RICHARDSON

NOTES

THE death is announced of William Froude, F.R.S., a name familiar to our readers in connection with experiments on wave-resistances and the form of ships. Mr. Froude, who had long been in weak health, left England in November last year, in H.M.S. *Boadicea*, for a holiday cruise to the Cape, and he died from dysentery on the 4th inst., at Simon's Town. We defer further notice of Mr. Froude's life and work till next week.

ANOTHER advance of the greatest importance has been made by the U.S. Signal Service in the department of practical meteorology. In the *Daily Graphic* for May 9, published in the afternoon at New York, is a map of the principal portion of the United States, with the weather conditions of the same morning. The map gives in distinct outline the lines of equal atmospheric pressure and of the temperatures over the United States, with the prevailing directions of the wind and the general weather conditions. By the aid of this map, which it is proposed to make a regular feature of the *Graphic*, any one can form a fair idea of the weather changes in any specified locality for some days to come. The observations indicated in the map were made at all the signal stations of the U.S. Government at thirty-five minutes past seven on the morning of the 9th, and having been collated at the central office in Washington at nine o'clock, were transmitted specially by telegraph to the *Graphic* by ten o'clock. All the details of the map have been carefully considered and are easily intelligible to any reader after a little study. The importance of this step cannot be overrated, and we only wish we saw the *Pall Mall* and other evening papers following the excellent example of their New York contemporary.

PROF. ASAPH HALL has been elected a corresponding member by the Paris Academy of Science to fill the place in the astronomical section vacant by the death of M. Santini.

THERE is being erected at Meudon a large construction in connection with the Physical Observatory, where a large refracting telescope will be fitted up. During the time that the works are being carried on M. Janssen continues his solar photography on the site where his instruments have been established, in a part of the old Château. The diameter of the photographs obtained by direct operation is now 50 centimetres, and the time of exposure to solar radiation diminished to $\frac{1}{3000}$th of a second. The interval of time between two successive operations has been reduced to two minutes by the application of the revolver system. Although the two images may represent the surface of the sun at periods so near each other, M. Janssen has discovered that there is always a striking difference in the two images. It must be considered as proved by these observations that no spot on the sun can be regarded as being in a state of quiescence, even during so short a period, and that the changes are important enough to be perceived at the distance of the sun viewed from the earth, although the smallest spot observable must be regarded as having a surface larger than the whole of France, a second of arc on the sun being equal to the distance between Paris and Marseilles.

ADMIRAL MOUCHEZ has almost completed his museum of astronomy in one of the rooms of the Paris Observatory. Exclusive of the portraits of Bouvard, Arago, Leverrier, Cassini, and other directors, a series of the principal celestial objects has been painted on the walls by talented artists. In the middle is a glass case in which a number of instruments used by astronomers of former ages are exhibited. M. Mouchez intends to publish a monthly periodical, which will be called *Journal d'Astronomie*. A part will be reserved for the original communications of the astronomers of the Paris Observatory, and part devoted to reviewing foreign astronomical periodicals.

THE Paris Anthropological Society has recently awarded prizes as follows:—The Godard Prize (500 francs and a silver-gilt medal) to Dr. Le Bon, for a work on the development of the cranium according to civilisation, age, and sex; two honourable mentions (with bronze medals) to M. Ujfalvy, for the first volume of his "Journey in Turkestan," and M. Zaborowski, for his "Manual of Prehistoric Archæology;" the prize in French Ethnology to Dr. Chervin, for his statistical works; and honourable mention to M. Rivière for his prehistoric researches.

SIR WILLIAM THOMSON gave some valuable evidence on Friday before the Select Committee engaged in considering the subject of the electric light. He said that whereas one-horse-power of energy would only produce 12-candle gas light, it might produce 2,400-candle electric light. "The upshot of the experiments made at the factory of Messrs. Siemens, at Woolwich, and at the natural philosophy class of the University of Edinburgh, was that, allowing the practical estimate of one-horse-power applied in driving the engine, it had produced 1,200 candles of actual visible electric light, half the gross energy going to produce the light while the other half was lost in heating the machine and the wires. As the electric light was such an economical producer he anticipated that it had a great and immediate future before it. He believed before long it would be used in every case where a fixed light was required, whether in large rooms or small ones—even in passages and staircases of private dwellings. There was immense promise in the actual work carried out by practical men in the present day. There was a prodigiously greater economy in the transmission of mechanical force into energy in the case of the electric light than in the case of gas. With regard to regulators for the electric light, he had seen one the previous day—the Siemens regulator—which gave a steady, pure, and quiet light. The electric light was especially adapted for being placed high where it illuminated a wide area. It might be put upon an iron pole raised 60 feet high, or the old French plan of swinging a lamp on a wire from one side of the street to the other might be followed with advantage. Such a plan would be useful in doing away with the necessity for opal globes, which destroyed a large quantity of the illuminating quality of the light. Indeed, he was surprised that these globes had ever been used, wasting as they did 50 or 60 per cent. of the illuminating power. He considered that the advantages of using the electric light within buildings would be very great, because of the small effect it would have when compared with gas in heating and vitiating the atmosphere. In the case of electricity, the waves of light only became converted into sensible heat, not in the air, but on the ceiling or walls and floor of the room after they had done their work. With regard to the subdivision of the light, according to practical experiments, if the same amount of energy that was used in producing one large light was employed in producing ten feebler lights, none of those lights gave one-tenth of the amount of illumination of the one large concentrated light. Still there was nothing mathematically impossible in the matter, and it was quite possible that a plan of subdivision might be found by which the ten feebler lights would give a sum of illumination equal to that of the one larger light. He considered that the electric light as now developed was fit for use in large rooms. He was also of opinion that a great deal of natural energy which was now lost might be advantageously applied in the future to lighting and manufactures. There was a deal of energy in waterfalls. In the future, no doubt, such falls as the Falls of Niagara would be extensively used—indeed, he believed the Falls of Niagara would in the future be used for the production of light and mechanical power over a large area of North America. The electricity produced by them might be advantageously conducted for hundreds of miles, and the manufactories of whole towns might be set in motion by it. Powerful copper conductors would have to be used—conductors of a tubular form with water flowing through them to keep them cool. There would be no limit to the application of the electricity as a motive power; it might do all the work that could be done by steam-engines of the most powerful description. It seemed to him that legislation, in the interests of the nation and in the interests of mankind, should remove as far as possible all obstacles such as those arising from vested interests, and should encourage inventors to the utmost. As to the use of electricity by means of the Falls of Niagara, his idea was to drive dynamic engines by water power in the neighbourhood of the Falls and then to have conductors to transmit the force to the places where illumination or the development of mechanical power was wanted. There would be no danger of terrible effects being brought about accidentally by the use of such a terrific power, because the currents employed would be continuous and not alternating." This may be called a fanatical view of the electric light.

ON Tuesday night the electric light was put to rather a novel use, and one well calculated to test its practical and especially artistic value. At the Horticultural Society's *conversazione*, various forms of the light were adjusted so as to illuminate the magnificent array of fruit and flowers of all kinds and colours, with, we believe, complete success, the only drawback being the wretched state of the weather. Still it was clearly shown how admirably adapted this form of light is to any purpose in which it is essential that colours should be shown almost *au naturel*.

ON Monday evening Mr. J. F. Bateman, president of the Institution of Civil Engineers, received at a *conversazione* at the South Kensington Museum a large assemblage of distinguished representatives of science, literature, and art. The long galleries of models of machinery and naval architecture were thronged with eight or nine hundred visitors, and brilliantly illuminated with electric lights, presenting a scene of exceptional brilliancy. The electric lights employed were of many different systems, including the Jablochkoff candle, Siemens's apparatus, that of the Electric Lighting Company, fitted with Wilde's automatic carbon holders, Higgins's incandescent light, and many others, displaying both covered and naked lights. Many noteworthy models of machinery had been specially added for the occasion by well-known engineers. Among these new contributions, which attracted a constant succession of interested groups of visitors, were in particular a working model of the writing telegraph of Mr. Cowper, and Dr. W. H. Coffin's modification of M. Trouvé's minute electric lamp for surgical use. These, however, were only two among the numberless objects claiming attention in an exhibition full of interest and instruction.

AS usual the Geologists' Association have arranged an excursion for Whit Monday and Tuesday. This year it is to Bath, under the direction of Messrs. Charles Moore and W. H. Huddleston.

MOUNT ETNA is in a state of eruption; on the 26th an opening occurred on the northern side, from which issued dense volumes of smoke and flames.

THE administration of the scientific exhibition to be held at Paris from July to November next, is desirous to establish a special section of electricity if agreeable to intending exhibitors, consequently all the electricians who have subscribed already are requested to state their opinion.

A ZOOLOGICAL SOCIETY of New South Wales has been formed at Sydney; one of its chief objects is the acclimatisation of foreign animals.

THE Midland Union of Natural History Societies held its second annual meeting at Leicester on Tuesday and Wednesday, May 20 and 21, under the presidency of Mr. Geo. Stevenson, who delivered an address to the large body of members from all parts of the Midland Counties, who met together in the Town Hall, Leicester. He pointed out how the usefulness of the Union might be best developed, and urged the members to co-operate together in definite efforts to solve some of the many problems of local and scientific interest. The first work of the kind which some of the societies had already taken up was an examination of the glacial drift deposits of the Midland districts, a scheme for which had been published by Mr. W. J. Harrison, F.G.S., one of the secretaries of the Union, in the *Midland Naturalist*. In due time the results of these efforts would be made public, and from what was already known of the labours of the inquirers some valuable information will be published. The Union now includes twenty-four societies, and there were representatives present from most of them. The societies in the Union (numbering nearly 3,000 members) are the following:—Birmingham Natural History and Microscopical Society, Birmingham Philosophical Society, Birmingham and Midland Institute Scientific Society, Birmingham School Natural History Society, Burton-upon-Trent Natural History and Archæological Society, Caradoc Field Club, Cheltenham Natural Science Society, Derbyshire Naturalists' Society, Dudley and Midland Geological and Scientific Society and Field Club, Evesham Field Naturalists' Club, Leicester Literary and Philosophical Society, Northampton Naturalists' Society, Nottingham Literary and Philosophical Society, Nottingham Naturalists' Society, Rugby School Natural History Society, Oswestry and Welshpool Naturalists' Field Club, Peterborough Natural History and Scientific Society, Severn Valley Naturalists' Field Club, Shropshire Archæological and Natural History Society, Small Heath Literary and Scientific Society, Stroud Natural History Society, Tamworth Natural History, Geological, and Antiquarian Society, Woolhope Naturalists' Field Club. In the evening of the first day a most successful *conversazione* and exhibition of microscopes, scientific apparatus, experiments, &c., was held in the Leicester Museum buildings. On Wednesday about 200 members made an excursion to Charnwood Forest, which was divided into two sections—one, geological, under the guidance of Mr. W. J. Harrison, F.G.S., and the other botanical, of which Mr. F. T. Mott, F.R.G.S., was the leader. The annual meeting in 1880 was fixed to be held at Northampton under the auspices of the Northampton Naturalists' Society; Mr. Edward W. Badger (Birmingham), and Mr. G. C. Druce (Northampton) were elected hon. secretaries for the year; and Mr. H. E. Forrest (Birmingham) assistant hon. secretary.

WE are pleased to see that a Scientific and Historical Society has been formed at Launceston, under the presidency of the Rev. G. H. Hopkins. From the opening address of the president it is evident that the Society has formed a correct idea of what should be the work of a local society, and we trust that the members will work energetically together to carry out the programme thus sketched. The district covered by the Society may be said to include North-east Cornwall and North-west Devon between Dartmoor and Bodmin Moor, with the sea-coast on the north. The sections are archæology, botany, meteorology, zoology, and geology, and in all departments the district ought to yield rich fruits. The Society seems to have made a good start, and we shall watch its progress with interest. We trust it will enlist a large proportion of real workers.

AN interesting experiment was made on May 22 before M. Tresca, the sub-director of the Paris Conservatoire des Arts et Métiers. M. Chretien, an engineer of Paris, has constructed a set of two locomotive ploughs worked by rope traction according to the Fowler system. But instead of using steam power, M. Chretien has employed the electric current generated by a Gramme machine, and a stationary steam-engine. It has been determined by M. Tresca that one-half of the motive power generated by steam was really transferred to a distance of above one kilometre from the furnace. The motive power which has been utilised for farming land can be employed for excavating, or executing any description of work.

THE carrier-pigeon service is now in full operation in France, and has been placed under the direction of the head of aërial communication. The number of birds fed by the Government is 6,000. These pigeons are located in Paris and twelve other large fortified towns. A number of soldiers and officers have been taught the art of pigeon breeding, and carriers are constantly sent from place to place. The Minister of Public Instruction and the Minister of Agriculture have established prizes for pigeon races.

THE strong interest recently awakened in Owens College, Manchester, has been shown in a desire on the part of some of his admirers to do honour to the founder. This has taken the form of a memorial window, which is to be erected in St. John's Church, near the College; and the donors have commissioned Mr. W. G. Taylor, of Berners Street, to carry out the work, which will be completed towards the end of next month. At the foot of the three lights are the words "Ars, Religio, Scientia," symbolised by subjects illustrating music, charity, and astronomy. The arms of the College and of John Owens occupy the bases of the side lights.

ONE of the new Cardinals, Haynald, Archbishop of Kalocsa in Hungary, is eminent as a botanist, as we learn from the *Gardeners' Chronicle*, and is probably the first botanist who has ever held so exalted a rank.

THE Sanitary Institute of Great Britain has issued a very satisfactory second Annual Report.

WE note that Dr. W. G. Farlow, for the past five years Assistant Professor of Botany at the Bussey Institution, Harvard University, has been appointed Professor of Cryptogamic Botany in the University proper. This is the first professorship in this important and difficult department established in the United States. The laboratory for instruction and research in the lower cryptogamia is now established at Cambridge.

FOR the schools of California, "A Popular Californian Flora; or Manual of Botany for Beginners," has (in part) been lately published by Mr. Volney Rattan, teacher in the Girl's High School, San Francisco. A second part will complete it. It is restricted to plants of the San Francisco region, extending north to Mendocino County, south to Monterey, and west to the foot hills of the Sierra Nevada.

"CINCHONA CULTURE IN BRITISH INDIA" is the title of a useful pamphlet by Surgeon-Major G. Bidie, Superintendent of the Madras Central Museum, being one of the Museum Popular Lectures of the season 1878-9.—We have received a separate copy of a paper "On Pollen," by Mr. M. S. Evans, read before the Natal Microscopical Society on November 18 last.—The Fifth Report of the Boulder Committee of the Royal Society of Edinburgh contains notes on a considerable number of boulders in Scotland, with numerous illustrations.—West, Newman, and Co. publish a monograph by Mr. P. H. Gosse, F.R.S., on "The Great Atlas Moth of Asia (*Attacus atlas*, Linn.)," with a coloured plate of its transformations.—We have received a very favourable Report of the Condition and Progress of the Davenport (U.S.) Academy of Natural Sciences, which is now in its eleventh year, and doing good and varied work.—"On the Lancashire Coal Fields," is the title of a paper by Mr. C. E. De Rance, reprinted from the *Proceedings* of the Geologists' Association.—A fourth edition of Bloxam's "Laboratory Teaching" has been issued by Messrs. Churchill. The most important alteration is the introduction of the formulæ representing the various chemical compounds described in the notes in the tables.

THE additions to the Zoological Society's Gardens during the past week include a Grey-cheeked Monkey (*Cercocebus albigena*) from West Africa, presented by Mr. Robert Surry; a Patagonian Sea Lion (*Otaria jubata*) from the Falkland Islands, presented by Mr. F. E. Cobb; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Mr. Head; a Blue-winged Green Bulbul (*Phyllornis hardwickii*) from India, presented by Mr. A. Jamrach; two Horned Lizards (*Phrynosoma cornutum*) from Texas, presented by Mr. E. Loder; a Javan Fish Owl (*Ketupa javanensis*) from Java, a Ceram Lory (*Lorius garrulus*) from Moluccas, three Abyssinian Guinea Fowls (*Numida ptilorhyncha*) from Abyssinia, a Nicobar Pigeon (*Calœnas nicobarica*) from the Indian Archipelago, a Victoria Crowned Pigeon (*Goura victoriæ*) from the Island of Jobie, a Mace's Sea Eagle (*Haliaëtus leucoryphus*) from India, two Black-tailed Godwits (*Limosa melanura*) twelve Common Widgeons (*Mareca penelope*), European, purchased; a Cheetah (*Felis jubata*) from Africa, two Bactrian Camels (*Camelus bactrianus*) from Central Asia, deposited; two Black Swans (*Cygnus atratus*) from Australia, received in exchange; two Chinchillas (*Chinchilla lanigera*), a Black-necked Swan (*Cygnus nigricollis*), bred in the Gardens.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

FROM No. 6 of the *University College School Magazine* (London) we see that the editor's post is not altogether a pleasant one, though the number is very creditable. The U.C.S. Scientific Society seems in a healthy condition. In connection therewith we notice that a series of sixteen lectures are to be given during this term on the Science of Daily Life. We trust they will be well attended.

FROM the Report for 1878 of the Rugby School Natural History Society we learn that it is fairly flourishing. The entomological, geological, and archæological sections have been vigorous, though the workers in each are fewer than they should be. Altogether there does not seem to us to be that hearty interest in the Society among the boys that conduces to complete success; all the more reason, therefore, for the real working members keeping up their work with unflagging zeal and doing their best to enlist the sympathy and help of the indifferent. A satisfactory observatory Report from Mr. Seabroke is appended.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 1.—"On the Origin of the Parallel Roads of Lochaber, and their bearing on other Phenomena of the Glacial Period." By Joseph Prestwich, M.A., F.R.S., F.G.S., &c., Professor of Geology in the University of Oxford.

Of the various hypotheses that have been brought forward since the time of Macculloch and Dick-Lauder in 1818, to account for the origin of the Parallel Roads of Glen Roy, the one so ably propounded by Mr. Jamieson, in 1863, has been most generally received and adopted.[1] It is a modification of the views originally expressed by Agassiz, to the effect that the barriers of the lakes—to the shore action of which both the above-named geologists attributed the "roads," but were at a loss to account both for the formation and removal of barriers—had been formed during the glacial period by glaciers issuing from Glen Treig and Glen Arkaig, supplemented by others from Ben Nevis. The subsequent determination, by the Scotch geologists, of an intermediate milder period succeeded by a second cold period, led Mr. Jamieson, with whom the pre-glacial and glacial deposits of Scotland had been a subject of especial investigation, to conclude that the extension of these two places took place during the second cold period, which he thinks was of little less intensity than the first, and that, while the glacier from

[1] Darwin's well-known paper, in which he considered the "roads" to be old sea-beaches, appeared in the Philosophical *Transactions* for 1839. This marine hypothesis was afterwards earnestly advocated by R. Chambers and Prof. Nicol, but is no longer held by its distinguished author.

Glen Arkaig blocked up Glen Gluoy, the glacier from Glen Treig formed a barrier to Glen Roy.

The "roads" were, he considers, formed by long-continued shore action at each successive level of the lake, that level being determined by the height of the cols over which the lake waters escaped.

To these views it has been objected, by Mr. Milne-Holme and others, that it is difficult to conceive the glens to the north of the Spean Valley to have been filled with water while at the same time those on the south were filled with ice, and he advocates a detrital barrier formed of clay, sand, and gravel, by marine origin, when the sea stood some 3,000 feet higher than at present.

Prof. Nicol, also, has pointed out that, had lakes existed in Glen Gluoy, Glen Roy, and Glen Spean for the length of time required to form the "roads" by erosion, and to accumulate the deltas, the cols by which their surplus waters escaped during those periods must have cut a channel in the rocks in the same way that the rivers (which now represent the same drainage, or probably less) have since excavated their channels in the present valleys; whereas, although there are indications of water-wear in the passes, nothing like a defined river channel exists. Prof. Nicol attempted to explain the facts on the theory of the "roads" being sea beaches. But the absence of corresponding beaches outside those glens—the limitation of the highest "road" to Glen Gluoy—and of the second and third to Glen Roy, and the total absence of marine remains in any of the various drift beds, renders the marine hypothesis inadmissible.

Sir John Lubbock, looking at the form of the "roads" which has been described by Macculloch as parallel layers applied in succession to the sides of the hills, contends that such a form is incompatible either with the heaping up of materials on a shore line, or with their removal by erosion, as in the one case a notch and in the other a projecting ledge in the hill side would be formed, whereas, with one exception of one superior talus pointed out by Macculloch, no such structure exists. Sir John points out that a parallelism between the slopes may, however, have been formed by wavelet action, in consequence of the detrital matter taking, as it successively fell and was removed, the same angle of repose as that which the detrital slopes originally had, that angle being the same in water as in air.

Besides these objections to Mr. Jamieson's hypothesis, which the author considers valid, he points out the difficulty of conceiving that the Arkaig glacier could have ascended the hills at the entrance of Glen Gluoy to a height of not less than 1,200 feet, while at the same time a pass existed at the head of the glen only 500 feet high, which presented a ready outlet to the west coast.

It is a question also whether active glaciers such as Mr. Jamieson requires could have formed permanent dams to the large bodies of water pent up in Glen Gluoy and Glen Roy. Glacier lakes are occasionally formed in the Alps, as in the instance of the Margelen See; but they never last many seasons. The glacier is constantly on the move, and so long as it presents an unbroken front to the lake, so long is the barrier efficient, but when in the progress of the glacier a fissured mass of ice comes forward, the water at once escapes with greater or lesser rapidity, and cannot again accumulate until the defective ice has travelled past or the leak is repaired by winter frosts.

Equally difficult is it to imagine the existence of such vast glaciers as those of Glen Arkaig and Glen Treig, while the opposite glens of the Gluoy and Roy remained free from ice. The difference in the height of the hills is too slight to allow of so great a variation in the level of the snow line, and the cause suggested by Mr. Jamieson, viz., a great difference in the rainfall such as it now obtains in this district, can scarcely be maintained, for, although the annual fall at Fort William is 86 inches, and at Laggan 46 inches, the rainfall at Roy Bridge has now been found to be as much as 62 inches. Further, for the argument to be of any value, it should be shown that in the country further eastward, where the rainfall is much less, there was the like absence of glaciers during the second period, whereas Chambers and other geologists, including Mr. Jamieson himself, have shown that during that period local glaciers descended from every mountain range approaching or exceeding 3,000 feet in height—a height attained by the hills to the north as well as by those to the south of the Spean.

With respect to the so-called "deltas" of the Turret in Glen Roy, and of the Gulban in Glen Spean, which are supposed to have accumulated during the long time that the lakes filled the valleys, the author shows that the structure of the former is not in accordance with the bedded structure of deltas, but on the contrary, that it is formed of unstratified moraine *débris* 50 to 80 feet thick, with a thin coating of gravel water-worn and reconstructed from the underlying mass, and that the angle of terminal slope is not that of original deposition, but is due to wearing back of the terrace by the Roy, and the fall of the *débris* by weathering.

These are the objections of the author to the hypothesis of Mr. Jamieson, but while objecting to this exposition of the glacial theory, he considers that that theory affords the most satisfactory solution of the problem, only that he would suggest a different interpretation in explanation of the phenomena.

Dismissing the hypothesis of local glaciers of the second period of glaciation, the author falls back upon the original idea of Agassiz with the development acquired by more recent research, and assigns the Lochaber lakes to the close of the first period of great glaciation. He considers the phenomena are due to the peculiar physiographical conditions of the district, and shows that owing to the configuration of the country, the drainage of the Ben Nevis range is diverted into the lower part of the Spean Valley and the Great Glen near Fort William. These conditions which now give this area an excess of water drainage, must in the like manner, during the glacial period, have there led to an exceptional accumulation of ice.

The observations of MacLaren, Chambers, Milne-Home, Jamieson, James Geikie, and others, sufficiently prove the great thickness of the ice covering in this part of Scotland during the first period of intense glaciation. On the flanks of the Ben Nevis range, glacial striæ extend to a height of more than 2,000 feet, while everywhere the rocks in the lower parts of Glen Spean are intensely glaciated, as are also those at the head of Glen Roy on approaching the Col to Glen Spey, and around the Cols of Glen Glaster and Makoul. At the same time, the erratic blocks, with the beds of sand and gravel of foreign origin, which have been found widely distributed over the hills around Glen Roy to heights of from 800 to 2,100 feet, afford confirmatory testimony of the depth of the land ice which then covered the country.

With the incoming of this glacial period, local glaciers must have descended from every mountain range, and so long as the glacier of one steep glen became confluent with another of the same chain flowing in the same general direction, so long would their course be uninterrupted, and the propelling and abrading force maintained, as in the Alps at the present day; but when, emerging from these glens into valleys of small gradients dividing the several mountain chains, they met with glaciers descending from these other ranges, their progress was not only subject to be checked, and their forces neutralised, but their course diverted, for if the lines of natural drainage were barred, the ice took those of least resistance, although such might be uphill and against the lines of drainage. This, however, could not be effected without excessive pressure and heaping up of the ice at the points of junction.

These interferences must have been especially frequent in the valley of the Spean. On the one side, the glaciers descending the steep ravines of the Ben Nevis range, would issue into Glen Spean and project across it to the Glenroy hills opposite. Below to the west, the great Nevis Glen glacier emerged into the valley of the Lochy, while above to the east the great glacier, issuing from Glen Treig, flowed down Glen Spean; but, meeting with the aforesaid group of glaciers from Ben Nevis, was partly diverted over the flanks of Craig Dhu, and upon the entrance to Glen Roy.

While the glaciers from this system of mountains were becoming confluent in and filling Glen Spean, those from the opposite range of hills were descending Glen Roy, the Rough Burn, and the other ravines of that chain, and coming into collision with those of the Ben Nevis range. In the same way other valleys were focussing their glaciers upon the end of the Great Glen north of Ben Nevis, barring in that direction the passage of the ice down Glen Spean, and diverting it northward towards Loch Lochy and Loch Oich.

Therefore, the great mass of ice descending Glen Spean, in consequence of meeting with these obstructions, was driven to accumulate in mass in the lower part of that valley opposite Glen Roy, until overcoming further resistance and confluent with the Ben Nevis mass, it wheeled round into the Great Glen at Loch Lochy.

There is no doubt, also, from the direction of the striæ and the position of the transported boulders, that the mass of the Treig glacier struck across the valley of the Spean, and turned down its channel westward; but that a part ascended to the Col of Glen Glaster, and another passed up the Spean Valley, is doubtful. It is more probable that this glacier, after traversing Strath Spean, met with others coming down the Rough Burn, while these took an easternly direction to Loch Laggan and over the Pass of Makoul. The direction of the striæ observed by the author between the Rough Burn and Moy, points, he considers, to ice coming down from the hills on the north and joining this main east stream.

The effects of these great conflicting ice streams were not confined only to the piling up and accumulation of the ice. Although glaciers confined by the walls of narrow glens, and descending steep slopes exercise great abrading power, the observations of Charpentier and others show that when they emerge into broader and flatter valleys, they may pass over beds of loose detritus without disturbance except that of pressure. The terminal moraines of the many glaciers emerging into Glen Spean may, according to the varying conditions of the ice, have been pushed forward or rolled over by the ice, while the meeting of conflicting glaciers must have led to the deposition and heaping up of the glacial *débris* at the points of junction. The many checks and blocks that must have occurred during the growth of the great ice-sheet—the neutralisation of the ice-force in one place, and the centralisation of it in others—will serve to explain much that is peculiar in the distribution of this subglacial *débris* or Till, not only in Lochaber, but in other parts of the country, and at all levels.

The author then points out the many mounds and terraces in the Spean Valley formed of moraine detritus, though since levelled and often masked by a covering of gravel due to subsequent water action. To this cause also he attributes the large accumulation of *débris* at the entrance to Glen Roy, between Bohuntine and Glen Glaster, where he shows it to be in places 200 to 300 feet deep, and where it rises nearly to the level of the lower parallel road. Mr. Milne-Home has pointed out a similar deposit at the entrance to Glen Collarig, while the large mass at the entrance of Glen Spean, and now forming Unachan Hill, rising to a height of 613 feet, has been often described.

The next question discussed is the height of the land in relation to the sea at the period of the great glaciation, as it is not possible to suppose that with the great changes of level which took place subsequently, there is now a return to the *status quo ante* of the earlier period; and the author sees reason to conclude that the land then stood at not less than from 1,000 to 1,500 feet higher than at present, so that the Irish Channel was then above the sea level, and land extended a considerable distance westward from the present coast of Scotland.

This was followed by a submergence of not less than 1,200 to 1,500 feet in central and northern England, Wales, and Ireland, and of 600 feet in the southern part of Scotland, as proved by the occurrence of marine shells at those heights, and assuming for the north of Scotland a submergence, at all events, of 400 or 500 feet below the present level, this, added to the previous elevation of 1,000 to 1,500 feet, would establish a difference of 1,500 to 2,000 feet between the period of great glaciation and the succeeding period of submergence.

This difference of level would produce a twofold effect upon the climate—the one resulting from altitude which would be equal to a rise in the mean temperature of from 4° to 6° F., and that caused by the conversion of a continental area into an archipelago. The effects of the two causes could not be less than from 12° to 15° F., which is about equivalent to the difference of climate between Paris and St. Petersburg. There is also to be taken into account the probable increase of heat consequent on the gradual diminution of those conditions, whatever they were, to which was owing the cold of the glacial period.

The effect of those changes was to produce a thaw which gradually led to the destruction of the great ice-sheet, though subsequently other changes brought for a time a return of cold sufficient to maintain local glaciers in the higher mountain ranges. The conditions under which the ice-sheet would be placed during this period would be similar to that of glaciers where they extend below the snow line. In Europe the glacier gradients are usually so steep, and the ice is so fissured, that even in such positions water rarely lodges on the surface, but in the Himalayas, where glaciers descend into wide valleys with small gradients, and the summer heat is considerable, the glaciers often become covered with tarns and small lakes. They have been noticed by Sir J. D. Hooker, and more lately by Col. Godwin-Austen, who describes in the middle of one of these glaciers, a series of such lakes, some being 500 yards in length, and 200 to 300 in breadth, and of great depth. As intervening barriers give way, these lakes descend from lower to lower levels, and finally escape.

In the same way the old ice-sheet must have become covered with pools and lakes, for owing to the irregular surface of the ice, and the inevitable absence of all channels of drainage, the water must everywhere have lodged, until channels were formed, and a means of escape established. The extent of these bodies of water would depend upon the height and permanence of the obstructions. In the Lochaber district they were, owing to the causes before named, of great size and permanence, such as to form high barriers at the entrance to Glen Roy, Glen Spean, and Glen Gluoy, behind which the waters accumulated and rose until they found a channel of escape over the cols at lower levels, when a permanent water-level would be established so long as the main barriers existed.

It is well known that the Parallel Roads are terraces composed of perfectly angular fragments of the local rocks with a few rounded pebbles both local and foreign to the district. The former show an entire absence of any prolonged beach wear. The wear of the latter is due to other causes. The slope of the hills above and below the "roads" varies from 25° to 40°, and the inclination with the horizon of the "roads" themselves, which are from 50 to 70 feet wide, varies within the limits of from 5° to 30°.

Of the internal structure of the "roads" very little is known. The only published section is the one given by the Rev. Thomas Brown in his paper on the "Parallel Roads," and in this there is no appearance of any such structure as would result from successive additions to the ledge by the tipping over of *débris* removed from the shore.

Although, therefore, the "roads" indicate a line of water-level, there is nothing in their form or structure to show that they have been formed by the long-continued action of lake waters on a shore line. To what, then, are they to be ascribed?

What the conditions were immediately antecedent to the formation of the first, second, and fourth road, is not shown, but in the case of the third road the conditions preceding its formation are to be traced uninterruptedly from the conclusion of No. 2 "Road." When the lake stood at the level of "Road" No. 2, its waters escaped by the col leading to Glen Spey, while, when they stood at the level of No. 3 "Road," they escaped by the Glen Glaster Col. Now, as there is a difference of 76 feet between the height of the two cols, it is evident that a barrier must have existed on the latter col during the time the lake stood at the higher level. Whether the barrier was detrital or ice-formed is immaterial for the argument.

Now, it is well known to engineers that a breach once established in a detrital barrier becomes so rapidly enlarged that, if not at once stopped, nothing can stay the rapid destruction of the barrier, as, in the case of the Holmfirth, Crinan, and other floods. Nor is evidence wanting of similar catastrophes in connection with glacier lakes. In the notable case of the Gietroz Glacier barring the valley of the Drance, a lake nearly 2 miles, and at one end 200 feet deep, was drained in twenty minutes. The still greater flood recorded by Vigne in a branch of the Indus drained a lake formed by a detrital barrier, and estimated by Mr. Drew to have been 35 miles long by 1 mile broad and 300 feet deep at its lower end, in one day.

In the same way it is to be assumed that the Glen Glaster barrier, which was probably formed by a remnant of the glaciers descending from the mountain ranges (2,994 feet) at the head of the glen, gave way with great suddenness, and caused the rapid fall of the waters from the level of the higher "road" in Glen Roy to that of that glen's second "road," at the height of the Glen Glaster Col, when the escape of the waters was stopped.

Now, it must be borne in mind that at this time the great mantle of snow and ice which had so long covered the country was passing away, leaving the surface of the hills in Glen Roy covered with a thick coating of angular local *débris* mixed with sand and clay, the result of the intense cold and of the decomposition of the underlying schistose and granitic rocks. This and the glacial *débris* must have long remained bare and unprotected by vegetation; at all events that below the water-line was so. Now, the angle of repose of purely angular and subangular *débris* varies within the limits of from 35° to 48°, but that of clayey sands, which, when dry, is from 21° to 37°, becomes, when saturated with water, as low as 14° to 22°. The angle of repose of the hill-side *débris* would, therefore, depend on the relative proportion of the angular materials and their matrix, and on the extent of saturation. The slopes of the hills being on the whole greater than that of the angle of repose of the saturated under-water rubble, this latter, easily set in motion on the settlement of its constituent parts as the water drained from it would, as the level of the lake water fell, tend to slip or slide down with the falling water, and this slip would continue until the disturbing cause ceased, and the momentum of the mass was checked by the inertia of the water gradually coming to rest on reaching the level of the col of escape.[1] The effect of the arrested slide would be to project the mass more horizontally forward, and form a ledge. This ledge, modified slightly by subsequent subaërial action and weathering, and by the dressing of its slope on the occasion of the next fall of the lake, constitutes the "road."

Although in the case of the other "roads" there is not the same evidence of a minor col-barrier, as the results are alike in all, the causes which led to them must have been the same; and it is shown that there is nothing incompatible in the features of the ground with the existence of such barriers, or rather that there is some evidence in each glen, however slight, of water-lines at levels higher than the "roads."

Comparing the theoretical inferences of structure with the facts, so far as they are known, Mr. Brown's substratum of "clay with boulders indistinctly stratified with thin (lenticular) layers of sand," represents the sliding detrital mass; the finely stratified sand and clay—the sediment which subsided from the muddy lake waters after their fall; and the two to three feet of stones with clay—the subaërial fall of *débris* from the slopes above. In the substratum and overlying sediment, Mr. Brown found four species of fresh-water diatoms, while he found none in the upper bed. This fact serves to confirm the subaqueous origin of the body of the ledge, while it tends further to disprove the marine hypothesis.

Although there is in all the cols an entire absence of a defined water channel, such as would be worn by the long-continued flow of a river, there are in all of them traces of strong water action, such as might result from the temporary passage of a large and rapid body of water.

With respect to the main barriers acting as dams to Glen Gluoy, Glen Roy, and Glen Spean, they were due, as already pointed out, to the circumstance of an accumulation of ice at these spots so excessive and so high as to last long after the ice generally in the lower tracks had given way. Not, however, that any ice barrier could have been permanent for a great period of time, but this the author's hypothesis does not require. In any case, an ice-barrier in a state of rest will form a more effective barrier than when in motion.

Passing over the barrier at the entrance to Glen Gluoy, it is shown that the point where the Glen Roy barrier existed is that where a glacier coming down Glen Roy would meet in opposition the ice from Ben Nevis and the Spean Valley; and that this glen was occupied by a glacier is proved by the occurrence of glacial striæ on the rocks forming the bed of the valley near Dalriach, and of Till, or boulder clay, lower down the valley, nearer Achavady. But the great mass of the latter lies precisely on the spot where the Ordnance Survey have placed the line of barrier; it was there heaped up by the same conflicting causes that produced the barrier of ice. That it was originally larger and higher is proved by its occurring on the two sides of the valley, the river having worn a channel through it, and by the presence upon it of thick beds of water-worn and water-strewn gravel, the materials of which have been derived from the underlying deposit, and which was formed, in all probability, by the rush of the waters on the bursting of the barrier, for, in many places the gravel is thrown back and over, as though by downward and outward pressure of water in motion. This detrital mass extends for a length of two miles or more.

The great barrier needed at the entrance of Glen Spean is precisely on the ground that the great glaciers of Ben Nevis met the ice stream coming down Strathspean. Unachan Hill, which rises immediately behind the line of barrier marked by the Ordnance Survey, together with the rising ground on the flanks of the valley, consist of a thick substratum of till or boulder clay, with a covering of gravel, the latter formed in greater part, if not entirely, from the destruction of the former,

[1] Even now considerable slides occasionally take place on the steeper slopes of Glen Roy.

so that there is little doubt that the detrital barrier here also was at one time much more important. Still, although the detrital matter formed a considerable element, the author believes that the great mass of ice constituted the essential element in the barriers.

The Till, although accumulated in larger masses in the above-named sites, is found in places all up the valley, generally in the form of terraces covered by gravel, as at Inverroy, Murlaggan, Inverlaire, and elsewhere. There is one feature common throughout, namely, the levelling and terracing of this glacial *débris* by subsequent water-action, which could not have been effected in the still waters of a lake bed, but probably took place on the bursting of the main barriers and during the rapid outflow of the waters. The levelling of the original glacial mounds having been effected at the time of the drainage of the lakes, and having been then covered and masked by gravel, the terminal slopes were either formed at the same time by the outpouring waters as they fell to a lower level, or subsequently by wearing back by the present streams.

An objection may occur to the foregoing hypothesis, in that, with elements so variable as the problem has to deal with, the parallelism of the "roads" with the horizon, which has been remarked on by all observers from Macculloch downwards, could not have been maintained. For the detritus of the hill sides vary, however slightly, in the relative proportions of rock fragments and soil, while the slopes above and below the "roads" vary also in their angle, so that, as these conditions varied, so would the momentum of the sliding mass vary, whilst the resisting force of inertia would remain the same. The consequence would necessarily be, that the slide would continue at some places to a lower level than at others, and the line of the "roads" could not be throughout parallel with the horizon.

There is no doubt that, to all appearances, the "roads" are perfectly level, and such was the author's first impression; but afterwards, on referring to the elaborate 6-inch Ordnance maps, he found the levels there given clearly show that the "roads" are neither at the exact height of the cols nor are they perfectly parallel with the horizon, after allowing for the variable inclination of the "roads," and for the observations being made in their centre.

Instead of a perfect level water line, the "roads" are really slightly *waved*, the difference between the highest and lowest point being in the four "roads" taken in descending order, 15, 11, 15, and 12 feet; and while the level of the higher "roads" is in most instances *below* those of the several cols of escape, that of the lower "road" is in all instances *above* it. Thus in Glen Gluoy, the "road," which is never more than 1 foot above the level of the Turret Col, is in places 14 feet below it. The Glen Roy "roads," Nos. 2 and 3, rise 2 and 4 feet above the col of the Spey, and sink 7 and 13 feet below it; whereas No. 4 "road" is never less either in Glen Roy or Glen Spean than 2 feet, and rises at places to 10 and 14 feet, above the Pass of Makoul. Further, as the curves formed differ for each "road," the variations *cannot be due to a common cause, such as subsequent movements of the ground*, but must be owing to differing conditions in each case. Nor do the levels on the two sides of the valleys correspond; they often vary as much as 7 or 8 feet. It is therefore not possible to reconcile these variations with the hypothesis of the "roads" being lines of water level due to shore action; nor is the very variable inclination of the "roads" themselves compatible with that view.

In the higher "roads" the lower level of the curve is possibly due to the steeper slopes, whilst the fact that the lower "road," No. 4, remains above the level of the Pass of Makoul, may be due to the circumstance either of the slopes being less, or more probably to the fact of the lake having been so very much larger, the escape of the waters was more prolonged, and the fall slower.

Various phenomena in connection with the great ice-sheet in Lochaber, and their connection with the gener l question, are next considered. The author objects to the term of *m raine profonde* to describe the drift of sub-glacial origin, as ap to lead to misunderstanding, although Hogard and other geologists have used it in a wider sense. It is evident that the old ice-sheet acted under very different conditions to an ordinary glacier, and it is better to use such terms as moraine detritus or sub glacial detritus for the sum total of sub-glacial products of the former, than employ a term which was originally and still is generally restricted to a single and comparatively small product of the modern glacier.

Besides this sub-glacial *débris*, there is the larger quantity of *débris* that must have been scattered over the surface of the ice during its melting by streams and rivulets, or spread out in the temporary lakes which were formed at all levels, and may have given rise in many instances to sand and gravel terraces of variable extent. But though true beaches may be deposited in other glacial lakes, for ledges or shelves such as constitute the Parallel Roads to be formed, a number of conditions must have concurred—such as sufficient slopes, a detrital covering, barriers at the mouth of the glens, and cols of escape at their upper end.

As the barrier ridges on the old ice-sheet melted, or burst, the waters escaped to lower levels, carrying with them, on or beneath the ice, a large portion of the surface detritus. Formed at all levels up to 2,000 feet or more, these glacial lake waters, in descending to lower levels, met with yet larger bodies of water, and the transporting forces increased in power till the last stage was reached and open channels formed in the distant plains, leaving as marks of their passage down the valleys—here great banks of gravel—there deep beds of sand, according to the distance from the point of outburst. To these floods, combined with river inundations, and with the modifications wrought by subsequent fluviatile action, are due various forms of escars, terraces, and other less defined detrital accumulations.

Meteorological Society, May 21.—Mr. C. Greaves, F.G.S., president, in the chair. The following were elected Fellows of the Society:—A. C. Bamlett, C. Browne, H. Burkinyoung, W. Radford, F. Ramsbotham. The adjourned discussion on the Rev. W. Clement Ley's paper on the inclination of the axes of cyclones was resumed and concluded. The object of this paper is to call attention to the evidences recently afforded by the results of mountain observations to the theory that "the axis of a cyclone inclines backwards." The author first reviews the state of the question up to the present time, and details his own investigations chiefly founded upon the movement of cirrus clouds; he then refers to Prof. Loomis's recent "Contributions to Meteorology," in which is discussed the observations at the summits and bases of several high mountains, the results of which confirm the theory that the axis of a cyclone inclines backwards. The following papers were read:—On observations of the velocities of the wind, and on anemometers, by G. A. Hagemann.—On the relation between the height of the barometer and the amount of cloud, as observed at the Kew Observatory, by G. M. Whipple, F.R.A.S. The author shows that the average amount of sky clouded at Kew is a little less than seven-tenths of the whole, and that the amount covered varies inversely as the barometric pressure between the limits of 29·0 and 30·3 inches, the variation being the most rapid between 29·8 and 30·1 inches. Also that above 30·3 inches cloud increases with increasing pressure, attaining the mean about 30·5 inches, and rising above it at 30·6 inches.

PARIS

Academy of Sciences, May 19.—M. Daubrée in the chair.—The following papers were read:—Meridian observations of small planets at the Greenwich and Paris Observatories during the first quarter of 1879, communicated by M. Mouchez.—On the resistance of elliptical boilers, by M. Resal.—On a new derivative of nicotine, by MM. Cahours and Etard. This is got by heating nicotine (100 parts) and sulphur (20 parts) together. The sulphur acts first by removing hydrogen from the nicotine. When at 160° to 170° the mass has become fluid and chrome-green in colour, the heating is stopped; and in a few days yellow prismatic crystals are formed of the new substance. Sundry reactions are described. The authors consider nicotine as probably a combination of dipyridine and hydrogen. Sulphur, acting on 2 molecules of nicotine, transforms it, with separation of sulphydric acid into *tetrapyridine*.—Formal reasons of the economical superiority of the Woolf or compound engines, by M. Ledieu. These are shown in tabular form.—Researches on the proportion of carbonic acid in the air, by M. Reiset. He operated with large aspirators, of about 600 litres capacity, movable to various parts. He finds that free atmospheric air contains, on an average, 2·942 vol. carbonic acid per 10,000 vol. (The common statement is that the quantity in atmospheric air varies between four and six ten-thousandths in volume.) In very diverse conditions the extreme variations did not exceed 3 per 100,000. Comparative observations in woods and in fields showed small differences, the numbers being 2·917 CO_2 and 2·902 CO_2 respectively, for the same hour. Other cases were: Over a field of red flowering clover in June, 2·898 CO_2; over one of barley with luzerne, in July, 2·829 CO_2. Among a flock of 300 sheep in pasture, 3·178 CO_2 (showing a considerable increase); at Paris, in May, near the Parc Monceaux, 3·027 CO_2.—M. Daubrée communicated news of M. Nordenskjöld. Whalers had seen what was probably the *Vega*, blocked in ice near Behring Strait, not far from East Cape.—Mr. A. Hall was elected Correspondent in Astronomy in room of the late M. Santini.—On the transparence of the media of the eye for ultra-violet rays, by M. Soret. He operated with the eyes of oxen, calves, and sheep, using his spectroscope with fluorescent eye-piece. It is shown that the absorption by the whole of the media must render impossible the perception of rays whose refrangibility exceeds that of the extreme radiation of the solar spectrum, or the line U. The absorbent properties of the vitreous and aqueous humours are attributed to presence of albuminoid substances. The limit of transparence of the two humours is indicated by curves.—Independence of changes of diameter of the pupil and of variations of the carotidian circulation, by M. François Franck. The iris may be dilated or contracted independently of modifications of the circulation.—A letter from Buffon to Laplace in 1774 was communicated by the Marchioness de Colbert-Chabanais.—On the characteristics of functions Θ, by M. Jordan.—On functions such as $F(\sin\frac{\pi}{2}x) = F(x)$, by M. Appell.—On a property of entire functions, by M. Picard.—On the functions introduced by Lamé in the analytical theory of heat relating to ellipsoids of revolution, by M. Escary.—Preliminary study of the action of acids on salts, without intervention of a solvent, by M. Lorin. The results indicate in general a chemical action more or less marked, and which for fatty acids decreases from formic acid to each of its successive homologues. Applications:—1. Crystallisable acetic acid may be obtained with acetate of baryta and sulphuric acid. 2. Formic acid may be had, *very concentrated*, with sulphuric acid and formiate of ammonia.—On the presence of mercury in the mineral waters of Saint-Nectaire, by M. Willm. He confirms M. Garrigou's conclusion (which had been denied), though the quantity of mercury he got was much less.—On the changes of volume of the spleen, by M. Picard. The dilatation of this organ results from dilating nervous actions exercised on the digestive organs, while its contraction results from a special well-determined nervous action.—Researches on alterations of the blood in uræmia, by MM. Morat and Ortille. Carbonate of ammonia is always found in the blood, unless death come before the end of the second day. Its presence there is posterior to its presence in the alimentary canal.—On the mode of combination of iron in hæmoglobine, by M. Jolly. His analyses confirm a former conclusion, that iron exists in the blood corpuscle only in the state of phosphate.—On hæmatoxylic eosine and its employment in histology, by M. Renant. It reveals, by an elective coloration, the two orders of cells which constitute by their union a mixed acinus of the sub-maxillary salivary glands.—On the apparatus of sound in various South American fishes, by M. Sörensen. Vibrations are communicated to the air of the swimming bladder.—On the amyloid appearance of cellulose in champignons, by M. De Leynes.

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