THURSDAY, AUGUST 10, 1882

THE BRITISH ASSOCIATION

SOUTHAMPTON is to have the honour this year (as no doubt most of our readers are already aware) of receiving the British Association for the Advancement of Science during its fifty second Annual Meeting, which will take place between the 23rd of August and the 1st of September. The selection of Southampton for this purpose is happy in many respects. The town has a history, and is in itself attractive. It is near the sea, it is well-built, it has beautiful surroundings; its Public Parks and its Common are no mean objects of interest, it has superior hotel, boarding and lodging accommodation, and, above all, it is excellently supplied, as we shall see below, with Public and other Buildings in which to hold the General and Sectional Meetings of the Association.

The proximity of Southampton to the Continent induces a hope of the presence of some of the most eminent men of science of France, Germany and other countries. Steps have been taken to secure this; and the visit of the distinguished foreigners will probably form one of the leading characteristics of the meeting.

The town and its immediate neighbourhood have always been found extremely attractive to visitors, especially during the months of August and September, when a very large number of yachts assemble for the purpose of taking part in the great regattas which are held at Cowes, Ryde, Portsmouth, and Southampton itself; whilst the beautiful scenery of the New Forest and the Isle of Wight can easily be enjoyed. It will be seen in the sequel that ample provision has been made by the Local Executive Committee in this direction.

To the Archæologist, Southampton presents much that is interesting, possessing as it does many remains of great antiquarian value,—for instance, the Bar Gate and the old Town Walls, Towers, &c., the birth-house of Isaac Watts, the site of the old Spa, and other ruins,—whilst on the banks of Southampton Water stand the ruins of Netley Abbey. Within very easy access of the town are the City of Winchester, with its Cathedral, its College, and the Hospital of St. Cross; the town of Romsey, with its noble Abbey Church; the city of Salisbury with its beautiful early English Cathedral, its Blackmore Museum, Old Sarum, Stonehenge, Cherbury, and Wilton Park; and the village of Beaulieu, in the New Forest, with the remains of Beaulieu Abbey. On the shores of the Solent is Hurst Castle, and a little beyond, the Priory of Christchurch. In the Isle of Wight are Carisbrooke Castle, the remains of a Roman villa in the village of Carisbrooke, and the newly discovered Roman villa near Brading: to say nothing of the Queen's residence at Osborne House, and numerous other lovely sites and spots.

Special facilities have been granted by the respective authorities for inspecting the Royal Victoria Hospital at Netley, the great Naval Arsenal, Dockyard, &c., at Portsmouth, and the royal yacht *Victoria and Albert*.

To the Geologist the shores of the Solent display for his investigation rocks of the greatest interest, some of which at the present time occupy the attention of men most eminent in the science. Alum Bay, Headon Hill, Colwell Bay, and Whitecliff Bay, in the Isle of Wight will be visited by means of excursions, as also probably Hardwell Cliff and Bournemouth. The Purbeck Beds can easily be reached by those who desire to pursue the subject.

Southampton is within a little more than two hours railway journey of London; and by the through communications of the railways in connection with the South Western Company, can readily be reached from any part of the United Kingdom. It also affords special facilities to those who wish to include a sea passage in their arrangements for the autumn. Steam-packets, fitted with every comfort, ply between Southampton and the ports of London, Portsmouth, Plymouth, Falmouth, Cork, Waterford, Dublin, Belfast and Glasgow; and the mail-packets of the London and South Western Railway Company maintain constant communication with Havre, Rouen, Honfleur, Trouville, Caen, Cherbourg, Granville, St. Malo, and the Channel Islands.

With reference particularly to the arrangements for the forthcoming meeting of the British Association, it may be mentioned that H.R.H. Prince Leopold, Duke of Albany, occupies the position of President of the General Local Committee, and a confident expectation is indulged that, in company with the Duchess, His Royal Highness will be present during the week. The Vice-Presidents include some two dozen of the neighbouring nobility, and resident clergy and gentry. For Chairman of the Executive Committee we have the Worshipful the Mayor of Southampton (Mr. W. H. Davis); the Vice-chairman is Mr. W. E. Darwin, M.A. (son of the late distinguished Charles Darwin); the local Treasurer is Mr. T. Blount Thomas, a former Mayor of the Town; the local Secretaries are Mr. C. W. A. Jellicoe (the Borough Treasurer), Mr. J. E. Le Feuvre (one of the Borough Magistrates), and Mr. Morris Miles (an officer of long-standing on the Ordnance Survey, and President of the local Literary and Philosophical Society); whilst the Committee itself comprises about thirty of the local clergy, members of the various services and professions, &c., &c.

The President-elect is Mr. C. W. Siemens, LL.D., F.R.S., &c. The first general meeting will be held at the Skating Rink on Wednesday, August 13, at 8 p.m., when Sir John Lubbock, Bart., M.P., F.R.S., &c., will resign the chair, and the President-elect will assume his office and deliver an address. On Thursday, August 24, at 8 p.m., there will be a *soirée* in the Hartley Hall; on Friday evening, August 25, at 8.30 p.m., in the Skating Rink, a discourse on the Tides, by Sir William Thomson, LL.D., F.R.S., &c., Professor of Natural Philosophy in the University of Glasgow; on Monday evening, August 28, at 8.30 p.m., in the Skating Rink, a discourse on Pelagic Life, by H. N. Moseley, M.A., F.R.S., Professor of Anatomy and Physiology in the University of Oxford; on Tuesday evening, August 29, at 8 p.m., a second *soirée* in the Hartley Hall; on Wednesday, August 30, the concluding General Meeting will be held in the Skating Rink at 2.30 p.m. In addition to these arrangements, there will be a lecture to the operative classes in the Skating Rink on Saturday evening, August 26, by Mr. John Evans, D.C.L., V.P.R.S., &c., on "Unwritten History, and How to Read it;" and on

Sunday, the 27th inst., at the invitation of the Rector (the Rev. the Hon. Canon A. Basil O. Wilberforce), the Members of the Association, accompanied by the Mayor and Corporation, will attend Divine Service at the mother Parish Church of St. Mary, when a sermon will be preached by the Lord Bishop of Truro.

The sectional meetings will be held respectively in some one or other of the following places:—The Watts Memorial Hall, Zion Hall, the Grammar School, Portland Baptist Chapel, Kingsfield School, the Masonic Hall, the Philharmonic Hall, the County Court, the Friends' Meeting House, the Unitarian School, Taunton's Trade School, the Wesleyan School, the East Street Baptist Chapel, St. Andrew's School, &c.

The Rector has also invited the Members of the Association to a garden party in the charming Deanery Grounds on Monday, August 28, while the Southampton Yacht Club have conferred the privilege of Honorary Membership of their Club for the week on the members, &c., of the British Association; and the Hartley Council have placed the Hartley Institution entirely at the disposal of such members during their stay. The Dock Company will provide competent guides, &c., to conduct the members over the splendid series of local docks; and the Union Steam-ship Company will lend and provision their magnificent ship *Pretoria* for an all-day marine excursion (during which the boat exercise as used in case of storm, and the hose exercise as in case of fire, will be gone through), unless the vessel in question should meanwhile be required by the Government for Transport Service.

The scheme of excursions is very complete, and includes all-day excursions on Thursday, August 31, to Salisbury, Stonehenge, and Wilton Park; Portsmouth Arsenal, Dockyard, the Royal Yacht, &c.; and a marine excursion to Bournemouth, or round the Isle of Wight: as well as afternoon excursions on Saturday, August 26, to Alum Bay; Ryde, Brading, Whitecliff, Newport, and Carisbrooke; drives in the New Forest; Netley Abbey and Hospital; Romsey, Broadlands (the seat of Lord Mount-Temple), &c; Winchester and St. Cross.

The local Gas Company will give an illustration of improved gas-lighting in the Skating Rink, and from Holyrood Church to the Hartley Hall (in one direction), and to the Commercial Road (in the other); completely lighting both parts also of Portland Street, &c. The Edison Electric Light Co. will illuminate the Hartley Hall.

The various local factories (Messrs. Day, Summers, and Co., Northern Iron Works, Oswald, Mordaunt, and Co., Woolston Ship Building Works, &c.), and the yard of the Royal Mail Steam Ship Company will also be accessible to the Members and Associates with their friends.

The Mayors of Winchester, Ryde, and Newport have shown a hearty desire to co-operate with the Local Executive Committee, as have Lord Mount-Temple, and others too numerous to mention. There appears every probability that, so far as can be attained by sound, honest, local work, the forthcoming meeting will not be the least successful that the Association has held; but it must not be disguised that the Local Committee has been somewhat hampered by the financial difficulty, in which respect there is still time for those who have not subscribed to make amends by sending in their names to the Local Treasurer either as Donors, Guarantors, or both.

T. NORFOLK,
Assistant Local Secretary

THE CLIMATE OF ALEXANDRIA[1]

WE have before us seven and a half years' very full and satisfactory observations made at Alexandria, under the auspices of the Austrian Meteorological Society, from the commencement of 1875, from which a tolerably accurate account of the climate of this historically and otherwise important region of the lower Nile may be gathered. The observations have been made daily at 9 a.m., 3 p.m., and 9 p.m., and are quite continuous to the end of May last.

A marked feature of the atmospheric pressure is its comparative steadiness from year to year, attaining the annual maximum, 30·147 inches, in January, and falling to the minimum, 29·844 inches, in July, the difference being thus 0·303 inch. At Cairo the difference between the winter and summer pressures is 0·321 inch, the greater difference at Cairo being due to its lower summer pressure. The greater diminution of pressure in advancing from the Mediterranean towards the interior during the summer is an important element in the meteorology of Lower Egypt, on account of the changes of wind which result from it.

During the three winter months the direction of the wind in the morning shows a mean of 27 days for S.E., S., and S.W. winds, as against 28 days for N.W., N., and N.E. winds. On the other hand, during the three summer months, southerly winds are wholly absent, and N.W., N., and N.E. winds prevail on 79 days. Looked at broadly, northerly and southerly winds prevail in winter, northerly in summer, and northerly and easterly in spring and during October and November. The prevalence of easterly winds at these seasons is a striking peculiarity of the climatology of a large part of the Levant, and as regards the autumn, they are accompanied with a higher temperature than would otherwise be the case. During the afternoon the wind blows uniformly from some northerly point at all seasons, except in winter, when winds from the west also prevail, west winds being then 16 as against north winds 30. During the warmest months the wind is wholly from the north. The wind is also much stronger in the afternoon than in the morning. Thus the morning observations give 48 days of calms during the year, but the afternoon observations only 18; and for the seven months from May to November, there are only two days of calm, but for the same months the morning observations give 30 days of calm.

In connection with these changes of wind, the relative humidity is very interesting. The lowest humidity, 66, occurs in winter; but as the wind changes more completely into the north, the humidity rises gradually to the maximum, 76, in July, and in exact accordance therewith, whilst the daily range of temperature in winter is about 11°·0, in summer it is only half that amount. On the other hand, while the air at Alexandria approaches nearer

[1] "Meteorologische Beobachtungen an sechszehn Stationen in Österreich und drei Stationen (Alexandrien, Beirut und Sulina) im Ausland. (Wien, 1875-82)

towards saturation in summer, the sky at the same time becomes more completely cleared of clouds than in winter. Thus the mean cloudiness in winter indicates that four-tenths of the sky is covered, but in summer there is only one-tenth. This increased relative humidity, occurring simultaneously with increased clearness of sky, is an important feature of the climate of Alexandria, being productive of a heat in the direct rays of the sun much less intense than the clearness of the sky and the latitude might lead us to expect.

The mean annual temperature is 68°·7, the minimum being 57°·6 in January, and the maximum 78°·9 in August. The coldest January, 54°·0, occurred in 1880, and the warmest, 62°·1, in the following year, there being thus 8°·1 of a difference. No such difference occurred in the summer months. Thus the coolest August was 77°·7 in 1876, and the hottest, 80°·2 in 1880, the difference being only 2°·5. At Cairo the differences of temperature are much greater. The daily range is considerably greater than that of Alexandria; the mean temperature of January is 54°·1, and of August 84°·5, and as regards variation of the monthly temperatures from year to year, the mean of January was 50°·0 in 1880, but 59°·2 in 1881; and the mean of August was 80°·6 in 1876, but 90°·7 in 1877, the daily range for the two seasons being thus 9°·2 and 10°·1.

At Alexandria the mean annual rainfall is 8·12 inches, falling on 44 days. The largest annual fall was 10·75 inches in 1876, and the least 3·42 inches in 1879. The following are the means in inches for the months:—January 1·95, February 1·46, March 0·72, April 0·15, May and September 0·02 each, June, July, and August *nil*, October 0·58, November 1·52, and December 1·70. Heavy rainfalls are of occasional occurrence. During these seven and a half years the fall for one day exceeded an inch on 13 occasions. The largest of these falls 3·00 inches, occurred on October 7, 1876. Hail has been recorded on nine separate days in all, and thunder and lightning on eight days.

The following peculiarity in the annual march of the temperature is noteworthy. The mean temperature of June is 75°·0, July 77°·5, August 78°·9, September 77°·7, and October 74°·4, from which it is seen that September is warmer than July, and October nearly as warm as June. This peculiarity is still more striking if we look exclusively at the daily maximum temperatures which are so important an element of climate. To show this, we subjoin the means and extremes of the daily maxima, week by week, from July 1 to October 27:—

1876-81.	Means.	Highest observed.
July 1–7	80°·3	86°·2
,, 8–14	80·6	84·0
,, 15–21	81·6	86·2
,, 22–28	81·7	88·0
July 29–Aug. 4	81·8	86·5
Aug. 5–11	81·9	87·1
,, 12–18	82·2	86·5
,, 19–25	83·8	97·2
Aug. 26–Sept. 1	83·4	90·1
Sept. 2–8	83·4	95·0
,, 9–15	83·4	93·9
,, 16–22	82·4	88·0
,, 23–29	83·3	97·9
Sept. 30–Oct. 6	83·4	97·9
Oct. 7–13	82·1	103·1
,, 14–20	79·7	87·4
,, 21–27	79·3	84·0

Thus, then, we see that the highest temperatures during the year have taken place in the end of September and the first half of October, and that absolutely the highest temperature yet recorded, 103°·1, was on October 11, 1877; and that while the highest weekly mean occurred in the latter half of August, a secondary maximum, nearly as high, occurred in the beginning of October. It will be also observed that up to the close of October, the temperature is still nearly as high as in the beginning of July, but after this date temperature rapidly declines. That this is no chance result peculiar to the years of observation is shown by the recurrence of this feature of the climate year by year, as well as by the temperature of Jerusalem and other places in the East.

Practically, from May to September inclusive, no rain falls. The precise date of the commencement of rain greatly differs in different years. The following are the dates for each of the seven years, marking the earliest day on which at least one-tenth of an inch of rain fell, which may be considered as marking roughly the termination of the dry season at Alexandria: 0·18 inch on November 4, 1875; 3·00 inches on October 7, 1876; 0·22 inch on October 16, 1877; 0·93 inch on November 29, 1878; 0·27 inch on December 20, 1879; 0·15 inch on September 27, 1880; from which date the rainfall was all but *nil*, till 0·14 inch fell on November 27, and 0·32 inch on November 15, 1881. Leaving out of view the small sporadic fall in September, 1880, the earliest date for the termination of the summer drought was October 7, and the latest December 20, the mean date of the seven years being November 12.

On advancing from the Mediterranean sea-board into the interior, the climate rapidly changes; the rainfall becomes less and less, and then practically ceases; the air becomes drier, and the sky clearer; the sun's heat stronger, the nights cooler, and the daily range of temperature greater. At Cairo the rainfall is quite insignificant in amount, but occasionally pretty heavy falls occur. Thus on January 10, 1870, 1·02 inch fell, and on May 3 of the same year 0·67 inch. From January to May of the present year 1·16 inch has fallen, of which 0·80 inch fell during the six hours ending 7 P.M. of April 1. The temperature rose at Cairo to 112°·6 on June 5, 1872; to 113°·2 on May 25, 1873; and to 116°·4 on May 20, 1869, the highest recorded at Alexandria being as stated above, 103°·1. During September and October, the mean temperature of the two places is nearly the same, with, however, this essential difference, which must not be lost sight of; the days are much hotter and the nights much colder at Cairo, where consequently greater precaution must be taken against chills at night, these being the fruitful source of diarrhœa, and other complaints which often prove so disastrous during campaigns carried on in such climates as that of Egypt.

COLLIERY VENTILATION

The Principles of Colliery Ventilation. By Alan Bagot, Assoc.M.Inst.C.E., &c. (London: Kegan Paul, Trench, and Co., 1882.)

DURING the last ten years, or, ever since it has become necessary for colliery managers to obtain certificates of competency by examination, there has been a ready sale for books like the one before us, which treat of a few mining subjects in an elementary manner, and more especially of ventilation, and the chemical and physical properties of the gases that are commonly found in mines. Mr. Bagot has evidently taken considerable pains in amassing his information from various sources, some of them original; and, if we could only add that he appears to have exercised the same degree of care in placing it before the reader, in a concise and orderly form, we would have little else besides commendation to bestow upon his volume. As it is, however, we regret to observe that the whole book is written in a somewhat discursive and disjointed manner. It contains an impossible geological section on p. 109; and nearly every one of its chapters teems with rules and advice for the guidance of all sorts of colliery officials from the engineer to the collier. We had hitherto imagined that the General and Special Rules of the Coal Mines' Regulation Act were already wellnigh as complete as our knowledge and experience could make them up to the present time, and we think, therefore, that Mr. Bagot might, without impropriety, have appended to his work copies of those parts of both which have a direct bearing upon his subject, selecting his examples of Special Rules from amongst those which most meet with his approval. Instead of pursuing such a simple and commendable course, however, he chooses rather to give us his own ideas of what these rules ought to have been; he endeavours to supply what he considers to be omissions, and he makes many statements of a purely dogmatical character which could not bear the touch of close and careful reasoning. Let us take what he says about the duties of a *fireman*, at p. 73, as an example:—

"The fireman's duties are very hazardous. He is a *competent person solely employed to test the pit for gas.* When inflammable gas has been found (and we presume that all viewers will see the propriety of examining before each shift begins work, even where it has not been found) he has to examine the pit once in every shift, or once in every twenty-four hours; should he find gas, he must report the same in a book kept for the purpose. The Act should have made him post a notice at the pit-head containing extracts from the book, showing briefly where gas had been found throughout the mine. He also places 'fire-boards,' or notices of dangerous gas, at the entrance to headings which have been found in his examination to contain it. These boards should be painted red and made easily recognisable to miners who cannot read. Another most responsible duty of the fireman is to act as the 'competent person' where shots are being fired. No shots should be fired where naked lights are used in the vicinity, as a large volume of gas may exude or be discharged after the shot and so become ignited, although the ventilation may be ample; neither should lamps on Davy's principle be used for the operation, but self-extinguishing lamps, such as Stephenson's or Williamson's safety lamps."

The advisability, or otherwise, of substituting self-extinguishing safety lamps for those now commonly used is a question that has agitated the mining community on many occasions before now. Our author, however, seems to regard it as almost a question of his own raising, and as he takes it up with such zeal and pursues it with so much avidity, we propose to devote a few words to its discussion. In the preface we find him saying:—

"Her Majesty's Commissioners appointed to inquire into mining accidents in their 1881 Parliamentary Report draw attention to this risk"—the risk attending the use of Davy and Clanny lamps—"but I think that this report will be but little heeded judging from experience, inasmuch as, on April 25, 1879, I read a paper before the Institution of Mechanical Engineers on the subject, with experiments proving the defects in Davy's lamp and many other modified forms of it in use in mines; and in a work of mine published in 1878, I state the fact that the Davy lamp will explode in an explosive mixture travelling at a velocity of eight feet per second." . . . "If the Government will not be convinced of the folly of sanctioning the use of Davy, Clanny, and all non-extinguishing safety-lamps in mines, the only chance to avoid these disastrous explosions is to appeal to the common sense of mining engineers."

And again—passing over other intermediate references—at page 148:—

"I have continually pointed out the danger of using non-extinguishing lamps in fiery mines, and at last the attention of the Government has been called to the danger by the Commissioners, but great blame attaches, to my mind (*sic*) that this fact was ignored so long."

It seems to us to be both unjust and unfair on the part of our author to bait the Government after this fashion, inasmuch as it was already in possession of a vast mass of information concerning this formerly much-discussed question, long before he began to write about it. Davy himself knew and pointed out the defect of his lamp nearly seventy years ago. Dr. Pereira made experiments to illustrate the same thing for the information of the Select Committee on Accidents in Mines, which sat in 1835. In their Report, that Committee made most urgent representations on the subject to the Government of their day. At the same time a strong effort was made to introduce Upton and Robert's self-extinguishing safety-lamp, which now exists only as a historical curiosity amongst others of the same kind in the Jermyn Street Museum. In 1850 or 1851 the late Mr. Nicholas Wood revived the question, and made the first experiments we know of, which fixed the velocity at which the explosive air must be travelling before the flame will pass through the wire gauze. From that date until the time of his death, thirteen or fourteen years later, he continued to advocate the adoption of self-extinguishing safety-lamps, choosing Stephenson's for his model. About the year 1866 the North of England Institute of Mining Engineers appointed a Committee to consider the matter. They conducted a splendid series of experiments which literally exhausted the subject, and they published the results in their Transactions. About the same time the Government of Belgium appointed a Commission for the same purpose, who, after continuing experiments intermittently over a period of ten years, made a short report to the King, and the result was the immediate promulgation of a law making the use of Mueseler self-extinguishing safety-lamps compulsory in the mines of that country. Finally we might cite the experiences in France, the reports published under the authority of the Commission du Grisou, which has just brought its labours to a close, the interrogatories addressed by the same authority to the principal mining districts of France, the opinions expressed by the various engineers, the discussions which took place, the conclusions, and the official replies.

Having all these facts before its eyes, and remembering that, according to their own showing, the Commissioners on Accidents have stated nothing that has not been well-known for many years, the Government could not very well be "convinced of the folly of sanctioning the use of Davy, Clanny, and all non-extinguishing lamps in mines," unless it is favoured with some new reasons for doing so in addition to those that have failed to convince so many generations of its predecessors. The Government could not very well retain its dignity, and at the same time shift its ground at the instance of every comer who thinks he possesses the long-sought-for panacea; but there are some eager spirits in our midst who appear to be for ever bent upon goading it into a hare-like speed, forgetful, evidently, of the moral of the fable which gives the final victory to the more slowly travelling tortoise.

We have only one more remark to make, and then we must conclude this already too long notice, namely, that a book which is written ostensibly for the education and information of even a section of the community ought not to contain recommendations of different kinds of apparatus which are apparently made and sold for the pecuniary benefit of the author. Mr. Bagot can have plenty of opportunities for advertising his improved and patented appliances without scattering notices of them through the pages of his books; and we would fain hope and believe that he was unaware of the gravity of his fault at the time he was in the act of committing it in the present instance. WILLIAM GALLOWAY

OUR BOOK SHELF

Theogonie und Astronomie. By A. Krichenbauer. (Vienna: Carl Konegen, 1881.)

DR. KRICHENBAUER believes that he has discovered a new key to ancient mythology. With the help of the Iliad and Odyssey, the gods of Greece are resolved into stars and constellations, and the facts of astronomy are made to explain their nature and attributes, as well as the myths that were told of them. In the deities of Egypt, of Babylonia, of India, and of Iran, Dr. Krichenbauer finds fresh confirmations of his views. The development of this early astronomical theogony falls into two periods, the first period being one of creation and growth, the second of fixity and nationalisation. The first period has its "climacteric" in B.C. 2110, when the Ram already ushered in the year. But its real history belongs to that earlier age when the Bull took the place of the Ram, and it is the Bull, accordingly, which stands at the head of the religious system, and breaks in sunder the egg of the universe. The second period begins with the change of the summer solstice from the Lion to the Crab in consequence of the precession of the equinoxes, and thus falls about 1462 B.C., when the commencement of the year was transferred from the summer solstice to the vernal equinox. The equal division of the path of the sun into the twelve signs of the Zodiac took place about seven centuries later. This, briefly put, is the substance of Dr. Krichenbauer's work. His interpretation, however, of the passages of Homer upon which his theory is based, is purely subjective, and is not likely to commend itself to others. Homeric scholars, at any rate, will not admit that any portion of the Iliad or Odyssey is anything like so old as he would make them, or can contain traditions of anything like so old a period. His acquaintance, again, with the facts that modern research has recovered from the monuments of Egypt and Babylonia, is of the most meagre kind. Hence he is quite unaware that we happen to know a good deal about ancient Babylonian astronomy, and the history of the Zodiacal signs, as has lately been pointed out in NATURE, and that what we know is altogether inconsistent with his statements and conclusions. Thus the year began with the vernal equinox, and the heaven was divided into twelve equal portions at least as early as B.C. 2000, and probably much earlier, while it was in Babylonia that the constellations and Zodiacal signs were first named. On the other hand, there was not the remotest connection between the theology and mythology of Babylonia and Egypt. Before Dr. Krichenbauer again writes on this subject it would be advisable for him to be better acquainted with the results of modern Oriental research.

Atlantis: the Antediluvian World. By Ignatius Donnelly. (London: Sampson Low, Marston and Co. 1882).

OUR only reason for noticing this curious book is that the names of writers of authority which constantly appear in its pages may lead some readers astray. But the author, while quoting them, has neither assimilated their method nor understood the bearing of their facts. In spite of the patient labour bestowed upon the work, and the numerous illustrations with which it is adorned, it is merely another contribution to that mass of paradoxical literature which awaits the "Budget" of a second De Morgan.

The Early History of the Mediterranean Populations, &c., in their Migrations and Settlements. By Hyde Clarke. (London: Trübner and Co., 1882.)

DR. HYDE CLARKE has compared together the devices found on the coins and gems of various ancient cities and countries, in the hope of proving the connection of the populations to which they belonged. The list is a useful one, though defective, but it proves no more than that in a very late period of the history of the Mediterranean peoples certain obvious objects were selected in different places alike as emblems and devices upon coins.

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.*]

Speechless Man

IN his notice of my work on "Asia," in last week's issue of NATURE, Mr. Sayce finds fault with me for rejecting the modern doctrine that "man was speechless when the leading races were differentiated from one another." I certainly do reject that doctrine, but not on the ground that he supposes. I reject it as in itself to the last degree improbable, and as utterly inadequate to account for the conditions which have suggested it. Seeing that there are many more radical forms of speech in the world than there are radical physical types, if indeed any of the physical types can be regarded as radical, anthropologists have somewhat rashly concluded that these forms of speech must have sprung up independently of each other after the dispersion of an assumed speechless human race throughout the world. We are in fact asked to believe that the continents were first peopled, here by a black, there by a white, elsewhere by a yellow, a brown, or a red species, all possibly sprung of one stock, but all still ignorant of any except perhaps a sign-language at the time of the dispersion. Then there came a time or times when these diverse species began all of them to babble independently of each other in their diverse independent settlements. Consequently, while the races may have been originally one, the stock languages had each a separate starting-point, and therefore were never originally one. Hence this sufficiently violent assumption is made in order to explain the present diversity of speech on the globe. I, on the contrary, hold that it is a useless assumption, that it explains nothing, that it is an all but incredible hypothesis, and lastly that the present diversity of speech on the globe admits of another, a much more simple and rational explanation.

What are the facts? Col. Garrick Mallery has an interesting paper also in last week's NATURE, on Gesture Speech, in which he tells us that there are, or were, in the United States alone sixty-five stock languages differing from each other "as radically as each differed from the Hebrew, Chinese, or English." And how many more in Mexico, Central, and South America? In Europe we have at least one still surviving, the Basque. In Asia there are at least thirty-five or forty. But who will count the number in the Sudan, and in the Oceanic regions occupied by the Negrito, Papuan, and Melanesian tribes? It is no exaggeration to say that probably as many as two thousand of these stock languages have been evolved since man first began to utter articulate sounds.

Now if it be necessary to postulate two independent evolutions of human speech in order to account for two independent forms of speech, it follows that we must postulate two thousand independent evolutions of human speech in order to account for these two thousand independent forms of speech. Are the advocates of speechless races prepared to go this length? Or do anthropologists at all realise the nature of the problem, when they propose to explain the existence of fundamentally distinct languages by the assumption of a corresponding number of independent centres of linguistic evolution? If they draw the line short of one or two thousand such centres, how do they propose to meet the difficulty presented by so many separate types of speech? Frederic Müller left the problem just where it was when he arbitrarily fixed the number of physical and linguistic families at twelve.

But so marvellous is the evolution of speech, that one may well doubt whether it occurred even so many as twelve times ever since the appearance of man on the earth. For my part I decline to believe that it occurred more than once, if once be sufficient to account for the present conditions. And it is on this ground that I take my stand. Anything short of, say, two thousand evolutions of speech are inadequate; one suffices! Under like conditions speech becomes differentiated far more rapidly than physical features. The former is essentially more or less evanescent; the latter are relatively persistent. Hence during the many ages of man's life on the globe, his physical type has been but slightly modified, producing mere varieties—a black and woolly-haired, a yellow and lank-haired, a fair and wavy-haired variety, and so on. But the primeval linguistic type or germ has become differentiated into varieties, species and even genera, whence the various morphological orders of speech, four in number, and the many now fundamentally distinct groups and families developed within each of those morphological orders, some extinct, some dying out, some still flourishing. The germ itself, which served as the common starting point, but which was itself at first little more than speech "in petto," has long been effaced past all recovery. Hence, although starting from one common centre, it does not follow that the linguistic families now existing can ever again be traced back to that common centre. Aided as we are by embryology and the fossil world, can we trace back the various orders of plants and animals to their common centres? Yet no evolutionist doubts that they were differentiated from such centres. But language, although it may be said to have a sort of embryology within itself, revealing the growth of its inner structure, leaves no fossils behind it. Its "missing links" are lost for ever. Hence it is not surprising that, in dealing with the evolution of speech, much more must be postulated than is always necessary in dealing with the evolution of organised life. It follows that while Darwinism as applied to organisms may one day be established scientifically, Darwinism as applied to language, must always partake somewhat of the nature of a hypothesis. Meanwhile I submit that, on the reasons here given, the hypothesis of a common primeval linguistic germ is both rational and adequate, whereas the hypothesis of speechless races is both improbable in itself, and fails to account for the very conditions to explain which it has been invented.

A. H. KEANE

The Chemistry of the Planté and Faure Batteries

IN your issue of the 20th ult. there is a letter by Dr. Oliver Lodge on the recent experiments of Mr. Tribe and myself. While confirming our general results from his own experience, he asks a question about the lead sulphate into which we state the spongy lead is converted during the discharge of a Planté or Faure battery.

In an early stage of our investigation we satisfied ourselves that lead sulphate was capable of both oxidation and reduction by the voltaic current, under the circumstances found in these batteries. Our best experiment is described in NATURE of March 16. It was made by spreading lead sulphate on platinum plates; but I have just had it repeated with lead plates, so as to imitate more closely the conditions of actual practice. The sulphate was reduced by the electrolytic hydrogen as before. As, however, the reduction takes place first in close proximity to the lead plate, it is not easily recognised till the chemical change has advanced some distance, and a good deal of the white salt always escaped decomposition. But the circumstances of the actual practice are much more favourable for the reduction of the sulphate than were those of our experiment: for the sulphate is formed in perfect contact with the metallic lead of the plate or its spongy covering, and the reduction is doubtless facilitated by its intimate mixture with the excess of spongy lead. When we stated that sulphate of lead is finally the "only product of the discharge," we were referring to the disappearance of any peroxide, and did not mean to imply that in actual practice the whole of the spongy metal is usually converted into sulphate.

In our experiments Mr. Tribe and I have always employed a sufficiency of acid, and we have never found any difficulty in charging again a plate which had been discharged.

In conclusion, I may express my great satisfaction that Dr. Lodge is carrying on an independent inquiry into the obscure chemical changes that take place in these cells.

Bowness, August 5 J. H. GLADSTONE

The Late Prof. Balfour

PERMIT me to add a few words to Dr. Foster's admirable biographical sketch in the last number of NATURE, and thereby correct a slight error into which he has fallen. He assigns to me the credit of inviting our much-lamented friend to give lectures on animal morphology. It behoves me to say that I have no claim to so much foresight. The proposal, so characteristic of Prof. Balfour's ardent disposition, originated, to the best of my belief, with him, and all I had to do was to place at his service, with the consent of the Vice-Chancellor for the time being, my private room in the New Museums, which I was glad to see turned to so good a purpose, for hitherto but little use had been made of it. The result is sufficiently well known.

ALFRED NEWTON

44, Davies Street, London, August 5

M. Raoul Pictet's Corpuscular Theory of Gravitation

I BELIEVE that I can remove M. Pictet's uncertainties regarding the credibility of the presumptive origin of attractive force in the undirected motion of an all-pervading material ether, without adopting the desponding alternative to which he appears to be obliged (in perhaps needless extremities) to betake himself, that it might be conceded "without its being possible to explain it." My reasons for accepting the proposition without any doubt or question, would at least, I believe, if they could be submitted to him in a form of faultless coherence and completeness, relieve him from pursuing the laborious purpose, which I am perfectly assured from my own apprehension of the real character of the equivalence, and of the mode of establishment which it admits of, would fail in its intended object, of undertaking a series of pendulum experiments to prove it.

Before reading the translation in NATURE, vol. xxvi. p. 310, of M. Pictet's paper on a comparison between the potential and corpuscular theories of attractive force, I had in fact just assured myself satisfactorily of the correctness of exactly the conclusion of which he has given such a clear and distinct enunciation, from a theory of thermodynamic actions which proceeds upon an entirely different basis from that which he has skilfully, and in so many cases successfully, applied. The demonstration which I used is a sufficiently clear and consistent one to be convincing; but it is founded upon a chain of reasoning which is quite independent of that employed by M. Pictet, and it does not actually lead me to entertain the theoretical conclusion that the apparent force of gravitation on a planet will be in any measure directly dependent on, and variable with the varying velocities of other planets' motions in the solar system; but that it will be a constant effect of the ethereal medium. If therefore the proof which I could offer of his proposition deserves to be regarded as a valid one, it will not only avoid the necessity of any more experimental evidence than we already possess of the nature of gravitative action, but it will also afford at the same time a satisfactory confirmation of the kind of ethereal explanation of gravitation of which M. Pictet is in search.

I have been delayed hitherto in publishing my views of the primary character of thermo-dynamical principles by difficulties which at the outset attended their applications to explain the experimental phenomena of conduction and radiation. These difficulties, however, and others naturally incident to the development of a new physical conception, I believe that I have satisfactorily mastered and overcome. But I anticipate the needs of much greater expansions in the theory before it will avail as completely as in those important cases, to include and demonstrate properties of specific and latent heats, and of dilatation, and the other thermal phenomena of fusion and evaporation, and of vapour tension, to which M. Pictet has found for his theory such useful applications.

Taking his departure from an entirely different common principle of thermal actions from that with which I set out, the results of M. Pictet's researches will yet, I believe, accord intimately, wherever the two parallel methods have a common meeting-point, with my own deductions. I accordingly entertain great hopes of recognising among his examples of conformity to a common law and method, links and steps of demonstration in a complete theory of the properties of heat, in phases of its action where physical axioms not exactly akin to his own fail to furnish me with sufficient explanations of them; in the same way that it has afforded me great pleasure to offer full corroboration of M. Pictet's views, from my own inquiries, at a point where his theoretical hypotheses have proved insufficient to cope with an exceedingly extensive and general provision of kinetic laws, much more comprehensive in its physical relations than those mechanical deportments of which we observe the properties and laws in ponderable matter, when it is not under the more profoundly modifying and affecting influence of the all-energising power and all-pervading agency of heat.

Collingwood, Hawkhurst, July 29 A. S. HERSCHEL

M. Cailletet's Pump for Condensing Gas

AT page 308 of your last number you mention a pump invented by M. Cailletet for condensing gases, in which he uses mercury as a fluid piston, in order to fill every interstice of the pump barrel, and so expel the last atom of gas; of course, in this case, he would use an ordinary plunger pump, with both the inlet and outlet valves at the top, and the proper quantity of mercury in the barrel, so as to fill it completely in the downstroke of the plunger or piston.

It is curious that a similar pump is figured in the first volume of the *Mechanics Magazine*, 1823, page 232, as invented by Henry Russell; and I have always understood that a modification of this was used by David Gordon at the unfortunate "Portable Oil Gas Co.", to condense gas into the reservoir from which his lamps were filled. The patents are Gordon and Heard, 4391—1819, and David Gordon, 4940—1824; a company was formed at the time for using his lamps, and was worked for a few years, but the *royalties* having much exceeded the *profits*, the Company came to grief. ROBT. J. LECKY

3, Lorton Terrace, Notting Hill, August 2

Spectrum of the Light of the Glowworm

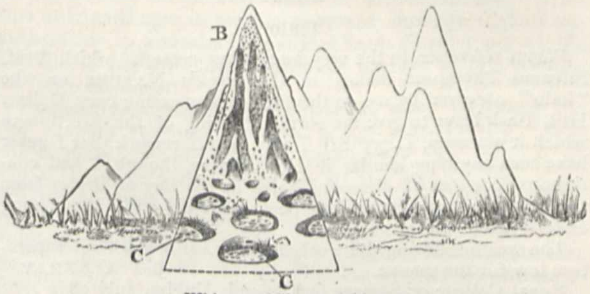
WHEN the subject of the phosphorescence of the Lampyridæ came under discussion at the meeting of the Entomological Society of London on February 4, 1880 (*Proc.* Ent. Soc., 1880, p. iii.) Mr. Meldola stated that "Some years ago he had examined the spectrum of the glowworm, and found that it was continuous, being rich in blue and green rays, and comparatively poor in red and yellow." This substantially confirms the observation of Sir John Conroy, although Mr. Meldola gives no measurements. JOHN SPILLER

Canonbury, August 5

White Ants' Nests

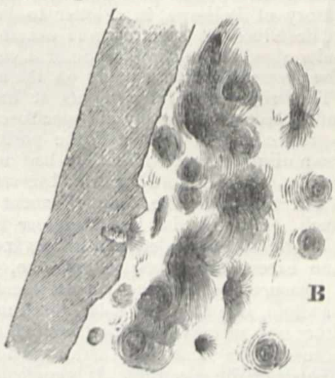
I OBSERVE in NATURE, vol. xxvi. p. 72, from line 13 to 35 inclusive, some remarks regarding the composition of the inner of the two distinct structures composing an ant hill, and that though the composition of the inner parts was chemically the same as wood, it was structureless, and its origin not known or understood.

I believe it is simply composed of the *excreted* refuse of the



White ant-hill, part laid open.

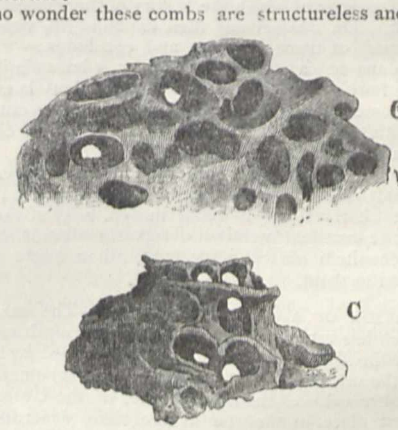
wood on which they feed, and formed into sub-spherical combs in which the young are generally found. The walls of the ant hill are of pure clay perforated with passages; towards the centre there are large chambers in which these combs are



B.—Part of clay walling, full of passages.

constructed, and they are full of passages and small chambers, the walls about 1-20th of an inch thick. I send some rough sketches that may serve to illustrate these, in case they may be worth insertion.

It is no wonder these combs are structureless and yet of the



C.—Part of a comb, full of chambers.

same chemical composition as wood. If a box full of papers or books is attacked the results are only too well known to those living in the tropics.

Asam, June 18 S. E. PEAL

Voice in Lizards

I HAVE been much surprised to see by the recent letters in NATURE that there was any doubt as to the lizard having a voice. I have so often heard and seen a lizard uttering its peculiar notes, that I did not imagine there was anything unusual in the circumstance. The voice is a shrill "chirp," and the whole body and tail vibrate simultaneously with its utterance.

Madras, July 9 SURGEON

Halo

WITH reference to the very interesting remarks which Prof. Silvanus Thompson makes in this week's NATURE on the "halo" observed by me on the 16th as appearing over Dalkey Hill, I ask leave to give the correct bearing of the direction in which it was seen, L. 35° S. I may further remark that I never have seen anything similar in this country, though I had continuous occasions of observing halos in the Bay of Biscay from the coast. They seemed to be connected with dominating easterly winds there.

The weather during the week has been rainy and the temperature low for the season. J. P. O'REILLY

Royal College of Science for Ireland, Dublin, July 28

OUR ASTRONOMICAL COLUMN

THE SPECTRUM OF WELLS' COMET.—Dr. B. Hasselberg, of the Observatory of Pulkowa, in a letter to Prof. Tacchini, dated June 30, describes his spectroscopic examination of this comet, the results of which he shows to be of a very exceptional character. The observations were made on the nights of June 4, 5, and 7. The brightness of the nights at Pulkowa in the summer had influenced unfavourably his spectroscopic observations of the great comet of 1881, and the position of Well's Comet was also a disadvantage, so that he had not expected a prominent spectrum, and the more because observations by Prof. Tacchini and Dr. Vogel at the commencement of April did not promise much. His surprise was therefore the greater on finding a very bright and extended continuous spectrum of the nucleus, with an excessively strong yellow line, of which the micrometrical measures proved the perfect identity with the yellow line of sodium, line D of the solar spectrum. This was a result altogether new in cometary spectroscopy, and the more noteworthy because at the same time there were no traces of the three ordinary bands of the spectrum. It is confirmed by Dunér, Bredichin, and Vogel. In the middle of May, on the contrary, Vogel's observations show that the three bands were then present, though faint, while of the sodium line there was not the least trace. It is therefore necessary to conclude that during the last fortnight of this month the spectrum of the comet had changed in a manner of which the history of the science furnishes no precedent. Dr. Hasselberg then explains his views of the *modus operandi* of these changes, and concludes:—"Je crois, donc, que dans le cas actuel, la chaleur solaire n'a joué autre rôle que de faire évaporer le sodium contenu dans la comète, et que les phénomènes lumineux et spectraux observés ont été provoqués et entretenus principalement par des décharges électriques mises en jeu sous l'influence du soleil."

This comet is again under observation in Europe. Prof. Julius Schmidt observed it at Athens as early as July 4; he gives his daylight observations in detail in No. 2447 of the *Astron. Nach.*, but the excellent meridian observations made at Albany, U.S., render them of less importance than might otherwise have attached to them.

OCCULTATION OF A STAR BY JUPITER.—The star 4 Geminorum, which has usually been considered a seventh magnitude, but is 7·4 in the *Durchmusterung*, will be occulted by the planet Jupiter, on the morning of November 8, the phenomenon being favourably observable at the observatories of the United States. The apparent place of the star at the time, according to the "Greenwich Catalogue" for 1864, is in R.A. 6h. 3m. 25s.·59, Decl. + 23° 0′ 57″·8, and at conjunction in R.A. Nov. 7, 14h. 12m., Washington M.T. it will be 5″ south of the centre of the planet according to Leverrier's position. Assuming the accuracy of the places, the immersion may be observed in this country.

NOVA OPHIUCHI, 1848.—Prof. Holder obligingly writes from the Washburn Observatory, University of Wisconsin, on July 22:—"In your note of May 4, 1882, you ask for an estimate of the magnitude of the *Nova* of 1848, whose position is (for 1880·0) R.A. 16h. 52m. 47s. N.P.D. 102° 42′. I looked for this object on July 18, and found it by help of your allineations with three stars which I had copied in my observing list, but I had, however, no note of its magnitude. There are three faint stars near it.—

1. Mag. 13 in $p = 25° \pm$
2. ,, 13·5 in $p = 160° \pm$
3. ,, 14 in $p = 270° \pm$

The *Nova* itself is between 12·5 and 3·0 mag. according to my estimate, and has no colour.

This estimate proves that no very sensible change has taken place since 1875.

SCHROETER'S OBSERVATIONS OF MARS.—Prof. Bakhuysen announces the publication of Schroeter's "Areographische Beiträge zur genauern Kenntniss und Beurtheilung des Planeten Mars," a work which he had designed to publish himself, and had nearly completed at the time of his death, in 1816. The manuscripts and copper plates were in the possession of H. Schroeter, of Linsburg, near Nienburg on the Weser, a grandson of the astronomer, and Prof. Bakhuysen having heard, through Dr. Terby, of Louvain, in December, 1874, that he had some intention of disposing of them to a scientific institution, took measures to obtain them for the Observatory at Leyden; the authorities in that University favourably received the application made to them, and provided the necessary funds for the purchase, and early in 1876 the Observatory was in possession of the manuscripts of the "Areographischen Beiträge," with fourteen copper plates belonging thereto. The publication has been undertaken by the firm of E. J. Brill, of Leyden. Two-thirds of the work appear to have been twice revised by Schroeter himself, so that the greater part of it is issued in the state which it was designed that it should be by the author. Prof. Bakhuysen mentions in his "Prospectus" that he had newly reduced Schroeter's observations for the position of the axis of Mars, and found its longitude and latitude 352° 59′ and 60° 32′, which is in nearer agreement with Oudemann's reduction of Bessel's few measures than with the recent determination of Schiaparelli.

KOREAN ETHNOLOGY

AT a recent interview with Mr. Charles Marvin, M. Semenoff, vice-president of the Russian Geographical Society, remarked that "every annexation in Central Asia is a source of satisfaction to our scientific men. Fresh fields are opened up for research, and all this must naturally be of interest to persons devoted to science." Some such thoughts will probably have occurred to most ethnologists on hearing that Korea has at last broken through the barriers of exclusiveness and concluded commercial treaties both with England and the United States. Foreigners will doubtless for some time be restricted to the three treaty ports thrown open on the eastern and southern coasts, and to Seul, the capital, where British and American political agents will reside. But the opportunities thus afforded of studying the interesting inhabitants of this region cannot fail to be gradually extended, until the whole peninsula becomes accessible to scientific exploration. Meantime a few notes on the ethnical relations of the people to their neighbours will probably be acceptable to the readers of NATURE.

The term *Korea*, now applied to the whole peninsula, was originally restricted to the northern state of *Korié*, the Chinese and Japanese forms of which were *Kaoli* and *Korai* respectively. With the fusion of Korié, Petsi, San-kan, Kudara, and all the other petty states into the present monarchy about the end of the fourteenth century, the name of the northern and most important of these principalities was extended by Japanese writers to the whole country, while the monarchy itself, at that time subject to China, took the official Chinese title of Chaosien (Tsiosen), or "Serenity of the Morning," in reference to its geographical position between the continent and Japan, the "Land of the Rising Sun." For the inhabitants themselves there seems to have been no recognised general name, although those of the southern division were commonly designated in Japanese history by the expression *Kmaso*, or "Herd of Bears," yet to the people thus contemptuously spoken of, the natives of the archipelago were indebted for a knowledge of phonetic writing, for their peculiar Buddhism, for their porcelain and some other industries. Political relations had been established between the two countries certainly before the third century of the new era, when a large portion of the Peninsula was reduced by the Queen Regent Zingu. Since then the political ascendency has oscillated between China and Japan, and the substantial independence hitherto preserved by the Seul government must be mainly attributed to the rivalry of its powerful neighbours.

The Korean race is commonly regarded as a branch of the Mongolic stock. But it really seems to have resulted from the fusion of two distinct elements, the Mongolic and Caucasic, the former no doubt predominating. These are probably the Sien-pi and San-han of Chinese writers, from whose union the present inhabitants are said to have sprung. The San-han (San-kan, or "Three Kan") prevailed in the central parts, and were apparently Mongols, while the Sien-pi, numerous especially in the south, are, perhaps, the above-mentioned Kmaso of the Japanese historians, representing the fair type, whose presence is attested by overwhelming evidence.[1] These Kmaso made frequent predatory excursions in very ancient times to Kiusiu and Hondo, even forming permanent settlements on several parts of the coast. It is probable that they also reached the Riu-kiu (Lu-Chu) archipelago, and thus may the presence be explained of a certain fair element in Japan itself, and especially in the Riu-kiu group.

The Caucasic seem to have preceded the Mongol tribes in the peninsula. But they were gradually out-numbered and largely absorbed by the yellow stock, owing to constant migrations, especially from the Chinese provinces of Pechili and Shantung, throughout the fourth and fifth centuries of the vulgar era. It is also to be noted, that with every revolution or change of dynasty in China, the leaders of the defeated party usually took refuge with their followers in Korea. The Mongol stock was thus continually fortified, while the stream of Caucasic migration had ceased to flow from prehistoric times. Hence it is not surprising to find that the prevailing type is now distinctly Mongoloid. Of the nine or ten million inhabitants of the peninsula, probably five-sixths may be described as distinguished by broad and rather flat features, high cheek-bones, slightly oblique black eyes, small nose, thick lips, black and lank hair, sparse beard, yellowish or coppery complexion. The rest, representing the original Caucasic element, are characterised by rounded or oval features, large nose, light complexion, delicate skin, chestnut or brown hair, blue eyes, full beard. Between the two extremes there naturally occur several intermediate shades, all of which serve to explain the contradictory accounts of the missionaries and travellers speaking from actual observation, but generally ignorant of the original constituent elements and ethnical relations of the natives. All, however, agree in describing them as taller and more robust than the Chinese and Japanese, while fully equal to them in intelligence and moral qualities. They are a simple, honest, good-natured people, very frank, laborious, and hospitable, although hitherto compelled by their exclusive laws to treat strangers with suspicion and an outward show of unfriendliness. That this unfriendliness is merely assumed through fear of the authorities is abundantly evident from Capt. Basil Hall's account of his intercourse with the natives of the islands on the west coast.

[1] The language of Ernst Oppert is conclusive on this point: "Unter den vielen Thausenden, die mir während meiner Reisen im Lande zu Gesicht gekommen, habe ich sehr viele von so edeln und charaktervollem Gesichtsausdruck gefunden, dass man sie, wären sie nach unserer Sitte gekleidet gewesen, für Europäer hätte halten können. Auch unter den Kindern war eine grosse Anzahl durch *ihre schönen regelmässigen Züge und rosige Hautfarbe, ihr blondes Haar und die blauen Augen* so auffällig, dass sie von Europäischen Kindern kaum zu unterscheiden waren, und ich mich des Eindrucks ihrer Abstammung von Europäern nicht zu erwehren vermochte, bis bei weiterem Eindringen ins Land diese Erscheinung eine sehr häufige und alltägliche wurde und diese zuerst gefasste Ansicht als irrig zurückgewiesen werden musste." "Reisen Nach Korea. Leipzig, 1881, p. 8. However untrustworthy this writer may be in other respects, his evidence on this question may be unhesitatingly accepted, agreeing as it does with that of so many other observers.

Polygamy, although permitted, is little practised, in this respect resembling their peculiar Buddhism. But while some consideration is shown for the women, to whom the streets are given up in the evening, the gods are treated with the greatest contempt and indifference. In many towns there are no temples, nor even any domestic shrines. The images of gods and saints are mere wooden blocks set up like landmarks by the wayside, and inferior as works of art to the idols of the Polynesians. When one of these divinities gets blown down or rots away, it becomes the sport of the children, who amuse themselves by kicking it about amid the jeers and laughter of their elders. The religious sentiment, which may be said to culminate on the Tibetan plateau, seems to fade away west and east as it descends towards the Atlantic and Pacific seaboards.

Formerly masters of the Japanese in many arts, the Koreans at present cultivate few industries beyond the weaving and dyeing of linens and cottons, and the preparation of paper from the pulp of the *Brussonetia papyrifera*. Silks and tea are imported from China and Japan, and the exports to those countries have hitherto been mainly restricted to rice, raw silk, peltries, paper, tobacco, and ginseng.

But for the Chinese influences, which are of comparatively recent date, the speech of the Koreans would betray few indications of their mixed origin. Here as elsewhere the primeval languages have refused to intermingle; the Caucasic has perished, the Mongolic alone surviving. But the dispersion took place at such a remote period that, beyond a general morphological resemblance, few traces can now be detected of any fundamental unity of speech between the Koreans and the surrounding Mongoloid peoples. Like the Manchu, Mongolian, and Japanese, the Korean is a polysyllabic, agglutinating and untoned language, with a rich phonetic system, including as many as fourteen vowels and several gutturals and aspirates. In structure and vocabulary it seems to approach nearest to the Japanese, with which W. G. Aston has compared it.[1]

The national writing system is purely phonetic, consisting of a syllabic alphabet of great antiquity, but unknown origin. It is probably an offshoot of the common alphabetic system formerly diffused throughout East Asia and Malaysia, and scattered members of which are still found amongst the Lolo and Mosso of South-west China, the Tagalas and Bisayans of the Philippine Archipelago, the Korinchi, Rejangs, and Lampungs of Sumatra, and the Dravidians of Southern India. In Korea, however, the literati use the Chinese ideographic system exclusively, leaving the despised native writing to women and children. This alphabet may be seen in the first volume of Dallet's "Histoire de l'Eglise de Corée," which has hitherto been almost our only authority on the subject of the Korean language and literature. Last year, however, a large Korean-French dictionary and a Korean grammar in French were published in Tokio. There is also a "Korean Reader," by Ross (Shanghai, 1879), which the writer has not seen.

A. H. KEANE

[1] "It seems probable that the distance which separates Japanese from Korean is not greater than that which lies between English and Sanskrit. . . . Everything considered we may regard them as equally closely allied with the most remotely connected members of the Aryan family." (*Journal* of the Royal Asiatic Society for August, 1879.) In this awkwardly worded sentence the writer does not mean to say that Japanese and Korean are allied to Aryan, but that they are as nearly related to each other as are the most remotely connected members of the Aryan family to each other.

THE COLOURS OF FLOWERS, AS ILLUSTRATED BY THE BRITISH FLORA[1]

III.—*Variegation and Retrogression*

SO far we have spoken for the most part as though every flower were of one unvaried hue throughout. We must now add a few considerations on the subject of the spots and lines which so often variegate the petals in certain species. In this connection a hint of Mr. Wallace is full of meaning. Everywhere in nature, he points out, spots and eyes of colour appear on the most highly-modified parts, and this rule applies most noticeably to the case of petals. Simple regular flowers, like the buttercups and roses, hardly ever have any spots or lines; but in very modified forms like the labiates and the orchids they are extremely common.

Structurally speaking, the spots and lines seem to be the direct result of high modification; but functionally, they act as honey-guides, and for this purpose they have no doubt undergone special selection by the proper insects. The case is just analogous to that of the peacock's plumes or the wings of butterflies. In either instance, the spots and eye-marks tend to appear on the most highly-modified surfaces; but they are perpetuated and intensified by special selective action. Lines are comparatively rare on regular flowers, but they tend to appear as soon as the flower becomes even slightly bilateral, and they point directly towards the nectaries. Hence they cannot be mere purposeless products of special modification; they clearly subserve a function in the economy of the plant, and that function is the direction of the insect towards the proper place for effecting the fertilisation of the ovary. In the common rhodendron, the connection can be most readily observed with the naked eye, and the honey tested by the tongue. In this case, one lobe of the corolla secretes a very large drop of nectar in a fold near its base, and the lines of dark spots appear on this lobe alone, pointing directly towards the nectariferous surface.

The *Geraniaceæ* afford an excellent illustration of the general principle. They are on the whole a comparatively high family of polypetals, for their ovary tends to become compound and very complicated, and they have many advanced devices for the dispersion of their seeds. *Oxalis corniculata*, our simplest English form, is pale yellow: *O. acetosella* is white, with a yellow base, and its veins are delicately tinged with lilac. The flowers of *Erodium* and *Geranium*, which are much more advanced, are generally pink or purplish, often marked with paler or darker lines. For the most part, however, these regular forms are fairly uniform in hue; but the South African *Pelargoniums*, cultivated in gardens and hot-houses, are slightly bilateral, the two upper petals standing off from the three lower ones; and these two become at once marked with dark lines, which are in some cases scarcely visible, and in others fairly pronounced. From this simple beginning one can trace a gradual progress in heterogeneity of colouring, till at last the most developed bilateral *Pelargoniums* have the two upper petals of quite a different hue from the three lower ones, besides being deeply marked with belts and spots of dappled colour. In the allied *Tropæolum* or Indian cress (Fig. 21) this tendency is carried still further. Here, the calyx is prolonged into a deep spur, containing the honey, inaccessible to any but a few large insects; and towards this spur all the lines on the petals converge.

In most regular flowers, the lines are mere intensifications (or diminutions) of the general colouration along the veins or ribs of the corolla; and they point towards the base or claw of the petal, where the honey is usually secreted. But in irregular flowers, we often get a higher modification of colour, so that one region of the petal is yellow or white, while another is pink or blue; and these regions often run transversely, not longitudinally. Such modifications usually affect the most highly-altered parts of the irregular flower.

The common wild pansy, *Viola tricolor*, affords a good example of complex variegation. Its flowers are purple, white, or yellow; or have these pigments variously intermixed. The two upper pairs of petals are usually the most coloured; the lower one is broadest, and generally yellow at the base, with dark lines leading towards the spur. *Viola palustris* exhibits the same tendency in a less degree; it is pale blue, with purple streaks. The whole family is immensely interesting from the present point of view, and should be closely observed by the student at first hand.

Among regular *Corollifloræ*, variegation is not very common, though it occurs much oftener than in the polypetalous classes, especially at the throat of the tube, as in the forget-me-nots (*Myosotis*); but in irregular *Corollifloræ* it is exceedingly frequent. The *Lentibulaceæ* and other small families afford several examples. In the great order of *Labiatæ*, the highly modified lower lip is very often spotted, especially where it is most developed. This is the case in *Stachys silvatica*, *Lamium purpureum*, *Galeopsis tetrahit*, *Calamintha acinos*, *Nepeta cataria*, *N. glechoma*, *Ajuga reptans*, *Scutellaria galericulata*, and many other species. Several exotic kinds show the same tendency in a more marked degree.

The *Scrophularineæ*, however, form perhaps the best example of any. We have noticed already that comparatively few of these are as blue or as purple as might be expected from their high organisation. The explanation is that they have mostly got beyond the monochromatic stage altogether, and reached the level of intense variegation. They are, in fact, a family with profoundly modified flowers, most of which are very specially adapted to very exceptional modes of insect fertilisation. The *Veronicas* alone among our English genera are simply blue, with white or pink lines; the others are mostly spotted or dappled. *Antirrhinum majus* is purple, sometimes crimson or white, with the curiously closed throat a bright yellow. *Linaria cymbalaria* is blue or lilac, with white patches, and the palate a delicate primrose. *L. spuria* is yellow, with a purple throat. *L. minor* is purple, with a white lower lip and yellow palate. The very strange flowers of *Scrophularia* have a curious, indescribable mixture of brown, green, dingy purple, and buff. *Sibthorpia* is pink, with the two smaller lobes of the corolla yellow. *Digitalis purpurea*, the foxglove, is purple, spotted with red and white. *Euphrasia*, eyebright, is white or lilac, with purple veins, and the middle lobe of the lower lip yellow. *Melampyrum arvense* is red, with pink lips and a purple throat. As a rule, the spots or patches of intrusive colour are developed transversely near the palate or around the throat. Purple, red, or blue appear to be the prevalent ground-tones, with white and yellow introduced as contrasted tints.

Among Monocotyledons, such plants as the highly modified *Iris* genus show similar results. Our own *I. fœtidissima* has blue sepals, with yellow petals and spathulate stigmas, all much veined. The *Orchidaceæ* exhibit the same tendency far more markedly. *Orchis mascula*, *O. maculata*, *O. laxiflora*, and many other British species have the lip spotted (Fig. 22). In *O. militaris* and *O. hircina*, the variegation is even more conspicuous. In *O. ustulata*, the spots on the lip are raised. The problematical bee-orchid, *Ophrys apifera*, is singularly dappled on the lip and disk, and has the sepals different in colour from the rest of the flower. *Aceras anthropophora*, the man-orchid, has green sepals and petals, edged with red, and a yellow lip, pink fringed. *Cypripedium calceolus*, the lady's slipper, *Cephalanthera grandiflora*, white helleborine, and most other British species, are similarly very diversified in colour. As to the exotic species, some of them are more peculiarly tinted and blended with half a dozen dif-

[1] Continued from p. 326.

ferent hues than any other forms of flowers in the whole world.

On the other hand, primitive yellow flowers of the earliest type never have any lines or spots whatsoever.

Besides the complications introduced by variegation, we have also to consider those introduced by retrogression. Flowers which have reached a given stage in the progressive scale of colouration often show a tendency to fall back to a lower stage. When this tendency is of the nature of a mere temporary reversion (that is to say, when it affects only a few individuals, or a casual variety), it may conveniently be described as Relapse. When, however, it affects a whole species, and becomes fixed in the species by a new and presumably lower adaptation, it may best be styled Retrogression.

Primary yellow flowers, like the buttercups and potentillas, show little or no tendency to vary in colour in a state of nature. They have never passed through any earlier stage to which they can revert; and they are not likely to strike out a new hue for themselves.

Some white flowers, on the other hand, show a decided tendency occasionally to revert to yellow, especially in the simpler orders. *Erysimum orientale* varies from white to pale primrose. *Raphanus raphanistrum*, as already noted, is usually even lilac, often white, and on the sea-shore yellow. The white cistuses often revert to a pale sallow tinge. In some roses, the throat becomes yellow in certain specimens. Stitchwort occurs yellow near Exeter. In

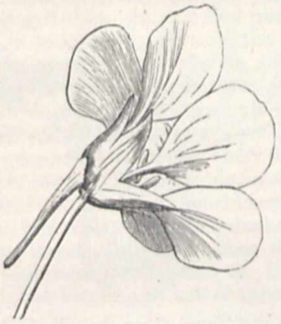


FIG. 21.—Flower of Indian Cress, orange with dark lines: the honey-guides point directly towards the long spur.

several other cases, stray yellow specimens of normally white species are not uncommon.

Pink and red flowers almost invariably revert in many individuals to white. A few typical instances must suffice. All the British roses are reddish pink or white. So are *Saponaria officinalis*, and many pinks. *Malva moschata* runs from rose-coloured to white; *M. rotundifolia* from pale lilac-pink to whitish. *Erodium cicutarium* has rosy or white petals; all the geraniums occasionally produce very pale flowers. White varieties of heaths are frequent in the wild state. Where the red or purple is very deeply engrained, however, as in labiates, reversion to white occurs less commonly. But almost all pink or red flowers become white with the greatest readiness under cultivation.

Blue flowers in nearly every case produce abundant red, pink, and white varieties in a state of nature. It would seem, indeed, as though this highest development of colour had not yet had time thoroughly to fix itself in the constitution of most species. Hence individual reversion is here almost universal as an occasional incident in every species. The columbine (*Aquilegia vulgaris*) is blue or dull purple, sometimes red or white. The larkspur (*Delphinium ajacis*) often declines from blue to pink or white. The monkshood (*Aconitum napellus*) is an extremely deep blue, very rarely white. White violets everybody knows well. The rampions (*Phyteuma*) vary from blue to white; so do many of the campanulas. *Gentiana campestris* is sometimes white. In most *Boragineæ*—for example, in borage, viper's bugloss, and forget-me-not—pink and white varieties are common. Pink and white *Veronicas* also occur in abundance among normally blue species. *Prunella vulgaris* occasionally produces rosy or white blossoms. White wild hyacinths are often gathered. Many other cases will suggest themselves to every practical botanist.

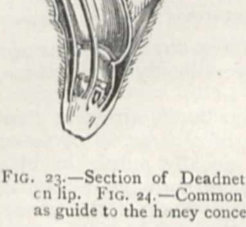
Blue flowers, however, very seldom revert to yellow. As a rule, the blue goes back only as far as those shades from which it has more recently been developed. This

FIG. 22.—Spotted Orchid, purple with white patches: type of highly developed bilateral monocotyledons.

is, perhaps, the true rationale of De Candolle's law of xanthic and cyanic types.

With the light thus cast upon the question to guide us, we may pass on to the general consideration of Retrogression in colours. Certain species of advanced families have apparently found it advantageous in certain circumstances to revert to colours lower in the scale than the normal hue of their congeners. The reasons for such Retrogression are often easy enough to understand.

We may take the evening campion (*Lychnis vespertina*) as a good example. This white flower, as we saw, is evi-



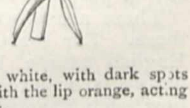


FIG. 23.—Section of Deadnettle, retrogressionary white, with dark spots on lip. FIG. 24.—Common Toadflax, yellow, with the lip orange, acting as guide to the honey concealed in the long spur.

dently descended from the red day campion (*Lychnis diurnia*), because it is still often pale pink, especially towards the centre, verging into white at the edge. But it has found it convenient to attract moths and be fertilised by them; and so it has lost its pinkness, because white is naturally the colour best seen by crepuscular insects in the dusky light of evening. Sir John Lubbock notes that such evening flowers never have any spots or lines as honey-guides on the petals.

The evening primrose (*Œnothera biennis*) is another excellent instance of the same sort. It belongs to the family of the *Onagraceæ*, which are highly evolved polypetalous plants, with the petals reduced to four or two in number, and placed above instead of below the ovary. We should thus naturally expect them to be pink or lilac, and this is actually the case with most of our native species. Why, then, is the evening primrose yellow? Because it is a night-flowering plant, fragrant in the evening, and its pale yellow colour makes it easily recognisable by moths. In this case, however, two points mark it off at once from the really primitive yellow flowers. In the first place, it has not the bright golden petals of the buttercup, but is rather more of a primrose tint; and this is a common distinguishing trait of the later acquired yellows. In the second place, it belongs to a genus in which red and purple flowers are common, whereas the buttercups are almost all yellow or whitey-yellow, and the potentillas mostly yellow or white. In short, primitive yellow flowers are usually golden, and belong to mainly

IG. 25.—Corn bluebottle, bigh: blue, highest type of Cynaroid composite.

yellow groups: reverted yellow flowers are often primrose orange, or dull buff, and occur sporadically among blue, red, or purple groups.

There are other cases less immediately apparent than these. For instance, *Lamium galeobdolon*, a common English labiate, belonging to a usually purple or blue family, is bright yellow. But we can form some idea of how such changes take place if we look at the pansy, which we have seen reason to believe is normally violet-purple, but which usually has a yellow patch on the lowest petal. In the pansy's var. *lutea*, the yellow extends over the whole flower, no doubt because this incipient form has succeeded in attracting some special insect, or else grows in situations where yellow proves more conspicuous to bees than blue or purple. So, again, another English labiate, *Galeopsis tetrahit*, the hemp-nettle, has a pale purple or white corolla, sometimes with a tinge of yellow in the throat; and in the var. *versicolor*, the yellow spreads all over the flower, except a purple patch on th lower lip. In *G. ochroleuca*, the whole corolla has become pure yellow. In this way, one can understand the occurrence of such a flower as *Lamium galeobdolon*, especially since an allied species, *L. album* (Fig. 23), is white, and all the genus is extremely variable in colour. Indeed, it is to be noted that the yellow labiates do not commonly occur among the less developed thymes, mints, and marjorams, but among the extremely specialised *Stachydeæ*, which have very modified flowers, and usually variegated or spotted lips. They seem to be essentially reversionary forms from purple or blue species, spotted with yellow.

Another hint of Retrogression is given us by flowers like our English balsams, *Impatiens noli-me-tangere* and *I. fulva*, in the fact that their yellow is generally dappled with numerous spots of deeper colour. The balsams are highly modified irregular *Geraniaceæ*, sepals and petals being both coloured; and at first sight it seems curious that our species should be yellow, while the simpler *Geraniums* and *Erodiums* are pink or red. But the genus as a whole contains many red and variegated species, and alters in colour with much plasticity in the hands of gardeners. *I. noli-me-tangere* is pale yellow, spotted with red; *I. fulva* is orange, dappled with deep brown. Both are almost certainly products of retrogressive selection.

In the *Primulaceæ*, we find similar instances. *Hottonia palustris*, a less developed form, is rosy lilac. *Cyclamen europæum* is white or rose-coloured. *Trientalis europæa* is white or pale pink, with a yellow ring. From such a stage as this, it is easy to get at our primroses, cowslips,

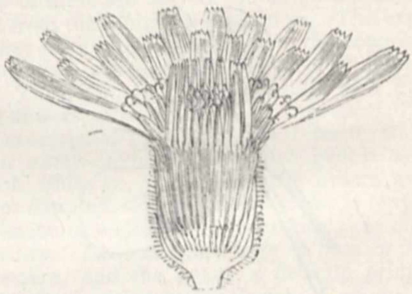


FIG. 26.—Section of Ligulate Composite, all the florets retrogressionary yellow.

and oxlips, which have pale yellow corollas, with orange spots at the throat. Indeed, one English species, *Primula farinosa*, is pale-lilac, with a yellow centre: and this might easily, under special circumstances, become pale primrose all over. The cultivated varieties of the cowslip, called Polyanthuses, readily assume various tints of orange, red, and pink, always at the edge, the deep yellow of the throat remaining unchanged.

The colours of many *Scrophularineæ* may be explained in the same way. Perhaps the yellow of the mulleins is primitive; but as some species are white or purple, it is just as likely to be retrogressive. In *Linaria*, we may almost be sure that retrogression has taken place; for we can trace a regular gradation from lilac flowers with a yellow palate, like *L. cymbalaria*, to pale yellow flowers, like *L. vulgaris*, which has the mass of the corolla primrose, and the palate orange (Fig. 24). *Mimulus luteus* is also yellow, but it is usually marked inside with small purple spots, and sometimes has a large pink or red patch upon each lobe. In *Melampyrum cristatum*, the yellow corolla is variegated with purple: in *M. pratense*, it has the lip deeper in hue. All these genera include many purple and variegated species; and the yellow members almost always bear evident marks of being descended from polychromatic ancestors.

The case of the yellow *Compositæ*, especially the *Ligulatæ*, is more difficult to decide. It would seem as though these plants, which have all their florets ligulate, must be more highly developed than the *Corymbiferæ*, which have only the ray-florets ligulate, or than the *Cynaroideæ*, which have no ligulate florets at all. Hence we should naturally expect them to be blue or purple, whereas they are for the most part yellow of a very primitive golden type, while the ray-florets of the Corymbifers are usually white or pink, and all the florets of the Cynaroids are usually purple. The following hypothetical explanation is suggested as a possible way out of this difficulty.

The primitive ancestral composite had reached the stage of blue or purple flowers while it was still at a level of development corresponding to that of the scabious or *Jasione*. The universality of such colours among the closely allied *Dipsaceæ*, *Valerianeæ*, *Lobeliaceæ*, and *Campanulaceæ*, adds strength to this supposition. The central and most primitive group of composites, the Cynaroids, has kept up the original colouration to the present day; it includes most of the largest forms, such as the artichoke, and it depends most of any for fertilisation upon the higher insects. All our British species (except the degenerate *Carlina*) are purple, sometimes reverting to pale pink or white, while *Centaurea cyanus* (Fig. 25), our most advanced representative of the tribe, rises even to bright blue.

Next to the Cynaroids in order of development come the Corymbifers, some of which have begun to develop outer ligulate rays. Here the least evolved type, *Eupatorium*, with few and relatively large florets, is usually purple or white, never yellow. But as the florets grew smaller, and began to bid for the favour of many miscellaneous small insects, reversion to yellow became general. In a few cases here and there we still find purple or white central florets, as in *Petasites vulgaris*, the butter-bur; but even then we get closely related forms, like *Tussilago farfara*, colts-foot, which have declined to yellow. The smallest and most debased species, such as *Solidago virga-aurea*, golden rod, *Tanacetum vulgare*, tansy, and *Senecio vulgaris*, groundsel, have all their florets yellow and similar; unless, indeed, like *Gnaphalium* and *Filago*, cud-weed, *Artemisia absinthium*, wormwood, or *Xanthium strumarium*, burweed, they have declined as far as colourless or green florets, in which case they must be considered under our next head, that of Degeneration. On the other hand, the larger and better types of Corymbifers began a fresh progressive development of their own. In many *Senecios*, *Inulas*, *Chrysanthemums*, they produced yellow ray florets, similar in colour to those of the disk. In *Chrysanthemum leucanthemum*, *Anthemis cotula*, *Matricaria inodora*, &c., these rays, under the influence of a different type of insect selection, became white. In the daisy they begin show signs of pink, and in the *Asters*, *Cinerarias*, &c., they become lilac, purple, and blue. Complicated as these changes seem, they must yet have taken place two or three times separately in various groups of Corymbifers, for example, in the *Asteroideæ*, the *Anthemideæ*, and the *Senecionidæ*.

The Ligulates were again developed from yellow-rayed Corymbifers by the conversion of all the disk florets into rays. Appealing for the most part to very large and varied classes of miscellaneous insects, they have usually kept their yellow colour (Fig. 26); but in a few cases a fresh progressive development has been set up, producing the violet-blue or purple florets of the salsify (*Tragopogon porrifolius*), the deep blue *Sonchus alpinus*, and the bright mauve succory, *Cichorium intybus*. As a whole, however, the Ligulates are characterised by what seems a primitive golden yellow, only occasionally rising to orange-red or primrose in a few hawkweeds.

That this hypothetical explanation may be the true one seems more probable when we examine the somewhat similar case of the *Stellatæ*. Here it seems pretty clear that mere dwarfing of the flowers, by throwing them back upon earlier types of insect fertilisation, has a tendency to produce retrogression in colour. Even in the more closely allied *Dipsaceæ*, *Valerianeæ*, and *Campanulaceæ*, we see a step taken in the same direction, for while the large-flowered *Campanulas* and *Scabiosas* are bright blue, the smaller flowered teasel (*Dipsacus silvestris*) is pale lilac, the *Valerianas* are almost white, and the *Valerianellas* are often all but colourless. In the *Stellatæ*, the same tendency is carried even further. As a whole, these small creeping weeds of the temperate regions form a divergent group of the tropical *Rubiaceæ* (including *Cinchoniaceæ*), from which they are clearly derived as a degraded or dwarfed sub-order. Now, the tropical *Rubiaceæ* have tubular blossoms with long throats, and as a rule with five lobes to the corolla; but many of the Stellates have lost the tube and one corolla lobe. *Sherardia arvensis*, which has departed least of our British species from the norma of the race, has a distinct tube to the corolla, and is blue or pink. *Asperula*, which approaches nearer to the retrograde *Galiums*, has one pale lilac species and one white. The *Galiums* have no corolla-tube at all, and most of them are white; but two British species, *G. verum* and *G. cruciata*, are yellow, and one of these has become practically bi-sexual—a common mark of Retrogression. *Rubia peregrina* is even green. This clearly marked instance of Retrogression from blue through lilac and white to yellow makes the case of the Composites easier to understand. No doubt the dwarfed northern Stellates have found that they succeeded better by adapting themselves to the numerous small insects of the fields and hedgerows, and therefore have fallen back upon the neutral colours, white and yellow.

After so many instances of more or less probable Retrogression, it will not surprise us to learn that in an immense number of other cases there is good reason to suspect some small amount of dwarfing or even Degeneration. It may have struck the reader, for example, when we were dealing with the Crucifers, that many of the smaller white forms were apparently lower in type than large and brilliant yellow flowers like the charlocks. That is quite true; but then, many of these small types are demonstrably dwarfed and slightly degraded, as, for example, *Cardamine hirsuta*, which has usually only four stamens instead of six, thus losing the most characteristic mark of its family. In *Senebiera didyma*, the petals have generally become quite obsolete; in some species of *Lepidium*, *Arabis*, *Draba*, &c., they are inconspicuous and often wanting. So in the smaller *Alsineæ* there are many signs of Degeneration. The normal forms of *Caryophyllaceæ* have two whorls of five stamens each; but these little creeping or weedy forms have often only one whorl, as in *Holosteum*, some *Cerastiums*, the smaller *Stellarias*, *Spergula*, *Polycarpon*, &c. In *Sagina*, *Cherleria*, and other very small types, the petals are often or always wanting. Indeed, most botanists will probably allow that nearly all our minute-flowered species, such as *Montia fontana*, *Claytonia perfoliata*, *Elatine hexandra*, *Radiola Millegrana*, *Circæa lutetiana*, *Ludwigia palustris*, *Peplis Portula*, *Tillæa muscosa*, *Myriophyllum spicatum*, *Hippurus vulgaris*, *Centunculus minimus*, and *Cicendia pusilla*, are distinctly degenerate forms. Though obviously descended from petaliferous ancestors, and closely allied with petaliferous genera or species, many of them have lost their petals altogether, while others have them extremely reduced in size. In several cases, too, the number of sepals, petals, or stamens has been lessened, and the plant as a whole has suffered structural degradations. Most of these dwarfed and degenerate flowers, if they have petals at all, have them white or very pale pink.

Readers of Sir John Lubbock's admirable little book on "British Wild-Flowers in Relation to Insects" will readily understand the reason for this change. They will remember that white flowers, as a rule, appeal to an exceptionally large circle of insect visitors, mostly of small and low grades. Hence, some among these very small flowers may often succeed, in certain positions, better than larger ones. Moreover, they will recollect that in numerous instances the larger blossoms of each family are so exclusively adapted to insect fertilisation that they cannot fertilise themselves; while among the smaller blossoms alternative devices for self-fertilisation commonly come into play after the flower has been open for some time, if it has not first been cross-fertilised. Structural considerations show us that in most of such instances the larger and purely entomophilous flowers are the more primitive, while the smaller and occasionally self-fertilising flowers are derivative and degraded, having usually lost some of their parts. Hence, in tracing the progressive law of colouration in the families generally, it is necessary, for the most part, to consider only the larger and more typical species, setting aside most of the smaller as products of degeneration.

GRANT ALLEN

(*To be continued.*)

NOTE ON THE HISTORY OF OPTICAL GLASS

M. FEIL has been good enough to send us the following interesting particulars of the life of Pierre Louis Guinaud:—

Pierre Louis Guinaud was born at Bresset in the canton of Neuchatel, Switzerland, in 1742, and died in 1821. He was nearly sixteen years old when Herschel visited Switzerland, and with Alschneider made some telescopic experiments on the Tête Doran. Young Guinaud, who acted as shepherd by day, and at night worked in a bell manufactory, occasionally was present at the meetings of these gentlemen, and attracted their attention and good will by many services.

His curiosity was greatly aroused, and after having been allowed to look through the telescope, he asked Herschel to dismount the instrument, as he wished to see how it was made; doubtless struck by his wonderful intelligence, the illustrious *savant* showed him the details of its construction.

The following year this gentlemen returned to Switzerland with Dollond and Faraday. Young Guinaud must have utilised the intervening time, for he showed Herschel, whom he was able to call his benefactor, a telescope which he himself had made, the mirror being of bell-metal. Imperfect as such an instrument must necessarily have been, it proved his strength of will and aptitude for optics.

He had pondered over the subject and asked why large object-glasses had not been made? There are no glasses in existence suitable to make them," was the answer. "Make some, if you can," said Alschneider. "I will make some," replied Guinaud. But he required money. He set to work, and, being a clever workman, soon invented the bells of repeaters, which proved very lucrative. All that he earned was devoted to the establishment of small glass-works. What power of research and perseverance must this man have possessed, who, without any other resource but his genius, started the most difficult branch of glass making, in order to solve a problem which was incomprehensible to Faraday and Dartigères? For ten years everything was devoted to his work. One casting failed, and was thrown into the torrent which flowed at the foot of the mountain on which he had built his factory. He had chosen the highest and most inaccessible point, having to defend himself against the ignorance of his neighbours, who treated him as a sorcerer, and several times his place was sacked. He utilised a stream of water in order to work a hydraulic wheel for the pulverisation of these materials, the sawing and working up of these blocks of glass. Nevertheless, the attention of the scientific world was already drawn to the modest worker. Alschneider had become his friend. About 1806 he sold a disc of six inches to Lerebours, and at nearly the same time he sent an eight-inch to Dollond; the problem was solved. He furnished Panchoni and Lerebour with discs of twelve inches. The twelve-inch object-glass belonging to Causham was bought for 2,500 francs by Faraday. Alschneider begged him to go to Munich and associate himself with Fraunhofer. But at the end of about three years the desire to see his mountains again took possession of him, and he renounced all his advantages and returned to continue his work alone. France offered him a pension from the state, a secret patent for fifteen years, and a factory fully established; but he refused to accede to the offers of the minister of Vitellius, and died in 1821. After his death his son, Henri Guinaud, who had always lived in France from the age of fifteen, was put into communication by Lerebours with MM. Bontemps and Thibaudau, proprietors of the glass-works at Choisy-le-Roi. He had seen several experiments during the journeys he had taken with his father. He taught these gentlemen all he knew of his father's processes, but, obliged by penury to quit them, he returned to Paris, and founded, with his son-in-law, M. Feil, my father, a small glass-work in the Rue Mouffetard. This was in 1832.

In 1838 Henri Guinaud received the gold medal of the Academy of Sciences, in 1839 the great prize in astronomy, one part of which was given to M. Bontemps. He presented to the Academy of Sciences a disc of eighteen inches diameter. I succeeded him in 1848, and was his pupil for six years. He died in 1851, carrying with him the regrets of all scientific men, who, like the Aragos, Gambays, Thénards, and Dumas, had appreciated his cleverness and his talents, and who were his friends and protectors.

NOTES

THE French Association for the Advancement of Science meets this year at La Rochelle, on the 24th in t., for its eleventh session. M. Janssen is the President elect. Two lectures are to be delivered, one by M. Bouquet de la Grye, on the deep water harbour of La Rochelle; the other by M. Hospitalier, on the electric light. There will be excursions to the places where oysters and mussels are cultivated. Deep-sea dredging will take place on board the *Ardisnade*, under the direction of Prof. Giard, of Lille. A reduction of 50 per cent. will be granted on the French railways to the members of the Association. Among foreign *savants* expected to attend the meeting are Prof. Hennessy of Dublin, Prof. van Beneden of Louvain, with several other Belgians, Prof. Baehr of Delft, and two other Dutch *savants*, Signor Denza, of Moncalieri Observatory, and two other Italians, Chevalier di Silva, Royal Architect, from Lisbon, Prof. Vittanova of Madrid, and M. de Loriol of Geneva. Among the subjects of papers we note briefly the following:—The Channel Tunnel; American glaciers; transformation of work into heat, and reciprocally; marbles of Italian quarries; employment of portable railways in the war in Tunis; geodetic works in Italy; the salubrity of collective dwellings; aërodynamics and solar heat; the topoveloce; a new gyroscopic box; a geometrical generation of Fraunhofer's lines; theory of vowels; isotherms on mountains; registering capillary electrometer; new pressure-anemograph; best coloured signals for beacons, &c.; sulphurous acid in Lille atmosphere; aërial navigation; photometry for light of different colours; severe winters; distribution of the atmosphere in the two hemispheres; ammoniacal fermentation; determination of salicylic acid in alimentary substances; action of oxalic acid on polyatomic alcohols; formation of alkaloids in protoplasm; bases of the quinoleic series; electro-therapeutic treatment of vomiting; double consciousness; teas of commerce; anæsthesia in croup; anthropology of evolution; the cause of goitre; intestinal parasites of oysters; thermal waters in the

Mediterranean basin; physiology of the nervous system; ocular hygiene; yellow fever; the Verbenaceæ; mints of France; European clover; funeral furniture of a dolmen; a palæolithic and neolithic station (see the *Revue Scientifique*, July 27 and August 5).

THE remains of the late Prof. Balfour were, on Saturday, nterred at Whittingham.

THE British Medical Association is holding its fiftieth annual meeting this week (beginning Tuesday, the 8th inst.) at Worcester, the city of its birth, under the presidency of Dr. W. Strange, of Worcester Infirmary. Among other events, a bust of Sir Charles Hastings (to whom the Association mainly owes its origin) is to be presented to the city.

A SEVERE earthquake is reported to have been felt in Chios (August 7), but no damage was done.

IT has been announced that an "Exhibition of Practical Electric Development," with reference chiefly to telephones, electric lighting, transmission of power, and the economical application of electric energy to practical work, will be held in the Royal Aquarium, Westminster, from November 1, 1882, till March 1, 1883. Prizes amounting to a total of 1000*l*. will be awarded by a Committee which the scientific societies will be invited to nominate. The subjects (in brief) are:—1. Best system of storage and generator for railway systems; generator to be worked from axle of train. 2. Best systems of storage battery, large and small. 3. Design in models, showing the best method of utilising (*a*) wind or water, (*b*) tidal forces for electrical storage. 4. Best electromotor for stationary or tram-car work (three kinds). 5. Best automatic (shunt or otherwise) system of dynamos for compensating change of resistance in external circuit, and economising power absorbed by machine. (6) Best model or drawing (with estimates) of central stations for 20,000 electric lights over a radius of one mile. 7. Best electric meter for houses. 8. Best set of twenty-five fancy fittings for electroliers. 9. Best set of fittings for restaurant or hotel bars, and counters. 10. Best application of electric light fittings to photographic studio. 11. Best fittings, &c., for drawing and other private rooms. 12. Best system of street mains or leads for public supply. 13. Best electric couplings for trains. 14. Best photometer, if possible, self-recording. 15. Best electro dynamo-meters (*a*) for direct, and (*b*) for alternating currents; both in one instrument. 16. Best thermopile for utilisation of waste heat and conversion into light or power by means of storage. 17. Best lamp for mine or sub-marine operations. 18. Most complete apparatus for remedial appliances, especially with regard to use of a bath in which the patient is immersed. Applications for space must be made (for England) not later than August 21.

THE *Times* Correspondent in Paris mentions having seen, at a recent popular *fête* at the Tuileries, a solar apparatus set in motion a printing machine, which printed several thousand copies of a specimen newspaper called the *Soleil Journal*. He also saw cider and coffee made with its aid, and a pump set in motion. He suggests the use of such apparatus for troops in Egypt and India.

WE are glad to learn that there is some prospect of an addition being made shortly to the small number of technical schools at present existing in this country, and that in a district where such a school, if properly organised, should prove of great utilty, viz., Cleveland. Mr. Samuelson, M.P., whose active interest in the subject of technical education has been so fruitful, has been discussing with some of the leading manufacturers in Cleveland the propriety of establishing a science school, having special reference to chemistry and metallurgy, at Middlesborough, and we understand that the proposal has been received with general approbation, and a definite scheme will soon be put forth. It is estimated by Col. Festing that a building, including a lecture theatre to hold over 200, and all necessary accommodation, would cost at least 2500*l*., and that the laboratory fittings, &c., would cost 600*l*.; but it would be essential to look for a present expenditure of from 5000*l*. to 6000*l*., exclusive of land. As to maintenance, the institution would have a fixed revenue from fees; there will be payment for results, and some help towards a sustentation fund is looked for from the City Guilds of London. The cost of laboratory fittings would doubtless be partly met from South Kensington. Mr. Samuelson is prepared we hear, not only to contribute liberally towards the funds required for the institution, but also to give his personal and practical aid in the working out of the scheme. A meeting of those who sympathise with the movement will shortly be held, at which he and others will fully explain the objects and mode of operation. We trust that in the organisation of this school, due regard will be had to the interests of pure science, a thorough grounding in which is essential to true progress, on the part of the apprentice, in technical study.

MR. O'NEILL, H.B.M. Consul at Mozambique, has recently reported to the Foreign Office that from Mr. James Heathcote, of Inhambane (who was employed by him for the recovery of the body of the late Capt. Wybrants), he has received information of the discovery of a considerable tract of copal forest. Mr. Heathcote writes: "The forest where I obtained this gum, of which I send you specimens (I have collected six tons) is fully 200 miles long. It is a belt which runs parallel with the coast, and is midway between the coast and the first range of mountains. From Inhambane it is nearly 100 miles to get right into it." The distance of the forest from Inhambane is a little great, and may retard its being opened up; but its discovery adds to the known wealth of the district, and a new export to the place. Mr. Heathcote points out the following curious coincidence, and although it may not be the first time that attention has been drawn to it, the Consul mentions it: "The native name of this gum is 'Stakate' and 'Staka.' The Zulu name for gum is 'Inthlaka.' The name 'Stacte' mentioned in Exodus xxx. 34 (this is believed to be the gum of the Storua tree, *Styrax officinale*), would be pronounced as the above native name. The tree domineers over all, and standing in any place overlooking the forest, you see here and there trees growing as it were in a hay-field. The gum has a beautiful odour if pounded and burnt, also if boiled in a pot of water." The ordinary gum copal tree of the mainland of Zanzibar and Mozambique, though as a rule lofty, is by no means of the striking stature indicated by Mr. Heathcote's comparison.

THE Iron and Steel Institute hold an Autumn meeting in Vienna this year, from Tuesday, September 19th to the 23rd. Besides visits to engineering and other works in Vienna, and various entertainments, alternative excursions are arranged (for the 22nd) to Leoben and Gratz in Styria, and to Buda-Pesth, in Hungary.

THE American Committee for the Darwin Memorial (to co-operate with the English Executive Committee) has for its chairman Prof. Asa Gray; treasurer Prof. Alex. Agassiz. The other names are those of Baird, Dana, Eliot, Gilman, Hall, Leconte, Leidy, Marsh, Mitchell, Newcomb, Norton, Walker, and Wooley.

THE United States Bureau of Education issued not long ago a circular on the subject of Spelling Reform, which the Commissioner, General Eaton, pronounces to be of great importance. It contains a report, dated 1877, from four or five professors, who, after three years' discussion of the subject by the American Philological Association, were appointed a committee with recommendations which have been carried out as to reorganising the alphabet and cutting types to express distinct sounds now represented by one letter; also a similar Report of the Spelling Reform Association, with such new characters recommended both for printing and writing; and five new rules for writing words with present letters, which have become widely known, and a rather longer code of desirable changes. The circular contains also a sanguine account of the support and success that the movement has had in the States. It is a most interesting *résumé* of what amount of agreement has been arrived at among phonetic spellers and the moderate changes which they urge should be adopted first. But there are signs in it that there is small hope of all English-speaking nations agreeing upon a uniform standard of pronunciation, still less of their agreeing to represent uniformly the sound of such words in print; the result, therefore of the adoption of phonetic spelling must be the break-up of the English language, which it might have been hoped, would have become the language common to at least half the civilised earth. Each country—and it is hard to say how small division of each country—would soon have a brogue of its own, whose steadily increasing differentiation from all others will have nothing to check it. We have before our eyes now the small beginning of a natural confusion of tongues which the Hebrews of old well knew to be a curse, though ignorant of the process of evolution.

A USEFUL little "Guide to Southampton and Neighbourhood" has been prepared by Mr. Thomas W. Shore, of the Hartley Institution in that town, in view of the approaching visit of the British Association. A few pages are devoted to notes on climate, vital statistics, geology, botany, zoology, &c.

A PROPOSAL has been made to the Municipal Council of Paris to give the name of Miss Sophie Germain to one of the newly opened streets. This lady was a clever mathematician, who died about fifty years ago, and left some papers relating to high analysis.

THE Astronomical and Meteorological Bulletin of the Observatory of Rio de Janeiro (April number) has an account of solar observations by M. Lacaille, on nine separate days in February–April, with reference to variations of the solar diameter. The solar image was thrown on a screen which had a series of parallel lines directed perpendicularly to the diurnal motion. The passages of the sun's border over those lines were recorded in a chronograph. Each of the tables (referring to one day's observations) gives the angle of position of the solar equator reckoned from north towards east, the angle, north or south of the solar equator, which the diameter measured makes with the latter, the radius vector of the earth's orbit, and the sun's declination. The difference between the time of passage of the semi-diameter deduced from observation and that given by the *Nautical Almanac* is in general very small; it does not exceed 0·10s.

IN consequence of the long time which elapses between the meetings of the Meteorological International Congress, the President, Dr. Wilde, of St. Petersburg, has decided to form a permanent Committee to meet once a year, in order to examine and record the materials collected within such time. The first meeting of the Committee has just taken place in Copenhagen, lasting from the 2nd to the 5th inst.

THE Argentine Republic is at present organising two stations for observation of the transit of Venus; the first at Buenos Ayres, the second in the south of the province, in the environs of Tandil. One expedition is organised at the expense of the Argentine Government, and the other at that of the province of Buenos Ayres. The instruments have been ordered from M. Gautier, Paris; they are 6-inch and 8-inch equatorials. The two observatories are meant to become permanent; the Republic will then possess three, the principal one being that at Cordoba, established by M. Gould. The enlightened Governor of Buenos Ayres, M. Dando Rocha, has decided to carry out a scientific work of the first importance, viz. measurement of a meridian arc of 7° or 8°, which will serve as base for a geodetic map of the Argentine Confederation, and be of great interest for determining the form of the earth (southern measurements of the kind being very few).

WE have received from M. E. Hospitalier (whose work on the Modern Applications of Electricity, as translated and enlarged by Mr. Julius Maier, we reviewed in NATURE, vol. xxvi. p. 289) a letter, too long to insert in its entirety, complaining that for most of the points adversely criticised by us he is not responsible. He has courteously sent us a copy of the original edition, in French, of his work, that we might assure ourselves that his repudiation of what he justly terms *errors against common sense* was justified. M. Hospitalier protests against having been made to confound the *ampère* with the *coulomb*. He points out that in describing Edison's armature he described it as being founded in principle upon that of Siemens, not that of Gramme. He calls attention to the passage of his work where he says: "La machine Pacinotti a figuré à l'Exposition et a valu à son inventeur un diplôme d'honneur. Sa *priorité* et son identité de principe avec la machine Gramme *ne peut donc être contestée aujourd'hui.*" (The italics are M. Hospitalier's). We willingly accord to M. Hospitalier the claim he makes to repudiate the blunders for which he is not responsible, but we think he is a little too severe when he writes us that he is experiencing the truth of the Italian proverb, *traduttore, traditore.*

WE observe that a correspondent of a daily paper proposes that men addicted to the pursuits of science should be called *scientiates*, after the Italian *scienziati;* and in like manner the studies of science, *sciential* studies (*studj scienziali*). The substitution of the American *scientist* for our unsatisfactory phrase *men of science* is of course much to be deprecated; perhaps we shall come to accept Sir William Thomson's proposed use of *naturalist* for the designation in question, if its sense may be extended. *Scientific studies* is a phrase which cannot be commended for accuracy.

WE have received a letter from Rio de Janeiro stating that M. Crüls, the Imperial astronomer *pro tem.*, has established a time-ball similar to that at the Greenwich Observatory.

EXPERIMENTS have been made at Havre to test a system of telephony between the Roads and the city. They have been so successful that it has been proposed to form a pontoon structure at a distance from the land, on board of which public telephones should be placed for use by the shipping in communicating with the land.

THE credit for the French mission for the Venus transit has been recently voted by both Houses of Parliament, and amounts to 18,000*l.*

THE Budget Committee of the Chamber of Deputies proposes to the House to spend a sum of 3680*l.* for microscopical inspection of bacon and other meat liable to be infected with trichinæ. A special tax will be imposed on such goods for that purpose. There is a decided tendency to make the microscope an instrument of common use in the hands of the French administration.

THE conditions of habitability of Mars are discussed by M. Flammarion in the August issue of his excellent new journal, *L'Astronomie*. With S. Schiaparelli (who describes his recent observations in the same number), he accounts for the striking variability of geographical configuration of the planet by supposed alternate inundations and dessication of water, due to water-transformations much more important than those on our globe. There are also papers on Venus and her satellite, the tides in the Mediterranean, the heavens in August, &c.

A CURIOUS and little-known experiment, showing the resistance of the air in guns, is described by Prof. Daniel Colladon, of Geneva, in a recent letter to M. Melsens (*Bull. Belg. Acad.* No. 6). He was long in the habit of showing it to his classes. It resembles a feat that was sometimes performed by soldiers with the old Swiss carbines. M. Colladon fully charged with compressed air the hollow iron breech of an air-gun, serving as reservoir. Having screwed up the gun, he introduced a round lead ball, running freely, but nearly filling the bore; then, placing the gun vertical, he seized the upper end and pressed his thumb vigorously on the mouth. The gun was then "fired" by an assistant; the thumb remained in position, and the ball was heard to fall back in the bore. Thereupon, after recharging the breech and with the same ball, he shot the latter at a pine board about ·4 in. thick, or a pane of glass, and it passed through. The experiment, M. Colladon says, is without danger, if the operator is sure of the strength of his thumb, if the gun is more than 32 in. long, and if the ball is spherical and nearly fills the gun (in which it must act like a piston). The least uncertainty in the very vigorous pressure of the thumb, and hermetic closure of the gun, may entail serious injury to the thumb. While M. Colladon has repeated the experiment twenty or thirty times, without the least inconvenience either from shock or heat, a trial of it is perhaps hardly to be recommended.

THE additions to the Zoological Society's Gardens during the past week include a Common Raccoon (*Procyon lotor*) from North America, presented by Mr. Mark Vice; a Passerine Owl (*Glaucidium passerinum*), European, presented by Miss Maud Howard; six Common Guillemots (*Uria troile*), European, presented by Sir Hugh Dalrymple, Bart.; an Allen's Porphyrio (*Porphyrio alleni*), captured at sea, presented by Master J. Kennedy; forty Restless Cavies (*Cavia caprera*), British, presented by H.R.H. the Prince of Wales, K.G.; a Four-rayed Snake (*Elaphis quaterradiatus*), South European, presented by Capt. Adams; a Smooth Snake (*Coronella lævis*), British, presented by Mr. W. Penney; an Egyptian Cobra (*Naia haje*) from South Africa, presented by Mr. Eustace Pillans; a Common Viper (*Vipera berus*), British, presented by Mr. H. J. Benwell; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, a Grey Ichneumon (*Herpestes griseus*) from India, a Goffin's Cockatoo (*Cacatua goffini*) from Queensland, a White-headed Sea Eagle (*Haliaetus leucocephalus*) from North America, a Chequered Elaps (*Elaps lemniscatus*) from Brazil, deposited; three Black Lemurs (*Lemur macaco* ♂ ♂ ♀), a White-fronted Lemur (*Lemur albifrons* ♂) a Red-fronted Lemur (*Lemur rufifrons* ♂) from Madagascar, a Cape Hyrax (*Hyrax capensis*) from South Africa, a Westerman's Cassowary (*Casuarius westermanni*) from New Guinea, two Pileated Jays (*Cyanocorax pileatus*) from La Plata, two White-faced Tree Ducks (*Dendrocygna viduata*), two Rufous Tinamous (*Rhynchotus rufescens*) from Brazil, two Tataupa Tinamous (*Crypturus tataupa*) from South America, an Argentine Tortoise (*Testudo argentina*) from the Argentine Republic, two Common Chameleons (*Chamæleon vulgaris*) from North Africa, two Aldrovandi's Lizards (*Plestiodon auratus*) from North-West Africa, purchased; two Mocassin Snakes (*Tropidonotus fasciatus*), born in the Gardens.

THE EXCITABILITY OF PLANTS[1]

IT will be in the recollection of many who are present this evening that in February of last year I had the honour of delivering a Friday evening discourse on a subject which included that which has been announced for to-night. In that lecture I had hoped to present to you a comprehensive view of the excitatory motions both of plants and of animals; that is, of those motions which they perform in response to transitory impressions received by them from outside. I was desirous that the statements that I made to you with reference to animal excitability should be as fully as possible illustrated by experiments, in the carrying out of which much more time was lost than I had reckoned for; so that I was unable even to enter on the second part of my subject. The time at my disposal will not permit me to summarise my last lecture, however advantageous it might be to do so. I must content myself with recalling your attention to one or two fundamental points.

Under the term excitability are comprised all cases in which some definite change in the behaviour of a living structure, whether it be a whole animal or a part, constantly arises as the result of some transitory external influence. But for the purpose in view, those cases only were included (typical of the rest) in which some sort of muscular motion is performed in response to an excitation or stimulus. The effect of such excitation we call the excitatory process, and we say, as the result of observation, that it consists of two phases or stages—namely, the phase of latency, and the phase of visible effect. These were illustrated in the last lecture by a series of experiments in which the excitable tissue of the heart of the frog was used. It was first shown with reference to this tissue that when it is touched (that is excited) with the tip of a glass rod, it undergoes a definite change of form, at the same time doing mechanical work at the expense of material contained in, but not forming part of, its own substance; secondly, that this mechanical effect did not begin until the lapse of an easily measurable period after the excitation, ; it was then pointed out that the interval of time between the prick and the visible or mechanical effect—the change of form, or contraction of the contractile substance—was one during which, though no visible change occurred in the excited part, molecular changes must certainly be in progress, and that these were accompanied by electrical disturbance.

To illustrate this, I demonstrated to you that the electrical change which in all cases accompanies excitation, precedes the mechanical one in time. You will remember that by means of the electric light the outline of the muscle to be excited and the image of the galvanometer mirror were projected on the screen, and that we were able to observe that when the muscle was pricked, the electrical disturbance had time to produce a deflection of the magnet which was visible on the screen before the muscle contracted.

It was further shown that an excitatory effect analogous to that which in muscle constitutes the first phase is produced in nerve, that in both the process of excitation is capable of being propagated in the same sort of way that an explosion is propagated in a train of gunpowder, and, finally, that the existence in nerve of this endowment is the instrumentality by which, in the human body, the will is able to influence and govern all the rest, and to receive influences from outside.

To-night we shall occupy ourselves exclusively with plants. I shall endeavour to show not only that they possess the wonderful property of excitability by which one part is able to influence another part at a distance, but that there is reason for believing that the excitability they possess is essentially of the same nature as that of animal tissue. And now, without further preface, I propose to enter on my subject by first giving you a short account of some of the most instructive instances of excitable plants.

The number of plants which exhibit what is often called irritability is very considerable. I will not weary you with even enumerating them. You will see from the table that they are distributed among a number of natural orders, so that one might be inclined to suppose that in this respect no relation could be traced between the physiological endowments and the morphological characters of a plant. That it is not so we have abundant evidence. Thus in the same genus we may find all the species excitable, though not in the same degree. The extreme sensitiveness of the Chinese Oxalis, formerly called *Biophytum sensitivum*, because it was supposed to be particularly alive, appears in a less degree, but equally distinctly in our own wood sorrel, as well as in the Tree Oxalis of Bengal—the Carambola,[1] which is described in an interesting letter addressed by Dr. Robert Bruce to Sir Jos. Banks, and published in the Philosophical Transactions. Again, in the same order, as, for example, among composite plants, we may have the Thistles, Knap-

[1] Lecture delivered at the Royal Institution June 9, 1882, by Prof. Burdon Sanderson, F.R.S.

[1] An account of the sensitive quality of the tree Averrhoa Carambola. By Robert Bruce, M.D. *Phil. Trans.*, vol. lxxv. p. 356

weeds, and Hawkweeds, all showing excito-contractility in the same way, although the plants do not at all resemble each other in external appearance. In order to make you acquainted with the mechanism by which the excitable motions of plants are brought about, I will confine myself to a very few examples, selecting, of course, those which have been most carefully investigated.

Every one is acquainted with the general aspect of the sensitive plant. Probably, also, most persons have observed the way in which the leaves behave when one of them is touched, namely, that the leaf, instead of being directed upwards, suddenly falls, as if it had lost its power of supporting itself, and that the little leaflets which spring from the side stalks fold together upwards (Fig. 1). But perhaps every one has not observed exactly how this motion is accomplished, namely, that by means of little cylindrical organs the leaflets are jointed on to side-stalks, the side-stalk on to the principal stalk, and the principal stalk on to the stem. In those little cylinders, the powers of motion of the leaf have their seat. They may, therefore, be called the motor organs of Mimosa. I would ask your attention to their structure.

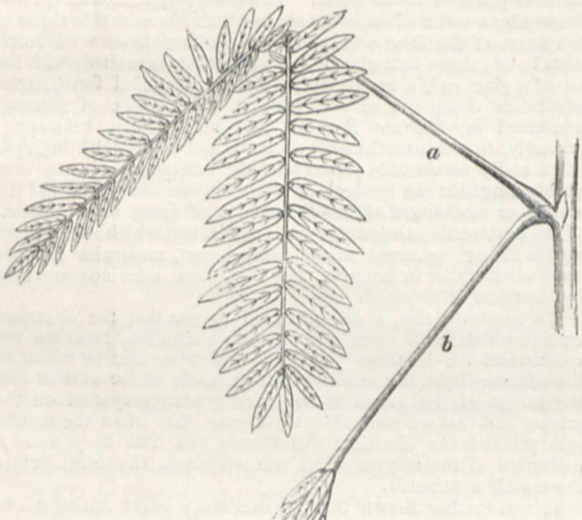


FIG. 1.—Leaf of Mimosa; *a*, in the unexcited state: *b*, after excitation (after Pfeffer).

In my description I will confine myself to the relatively large joint at the base of the principal leaf-stalk. If you make a section through it in the direction of its length, you find that it consists of the following parts. In the axis of the cylinder is a fibro-vascular bundle; above it are numerous layers of roundish cells with thick walls, and between these there exist everywhere intercellular spaces, which in the resting—that is the excitable—state of the organ, are filled with air. The surface is covered by epidermis. Below the axial bundle there are equally numerous layers of cells, but they differ from them in this respect, that their walls are more delicate (Fig. 2). And now let us study the mechanism of the motion. The literature of this subject is voluminous. Substantially, however, we owe the knowledge we possess to two observers—E. Brücke,[1] who studied it in 1848, and Pfeffer,[1] whose work appeared in 1873. I must content myself with the most rapid summary.

[1] Brücke, "Ueber die Bewegung der Mimosa pudica." Müller's "Archiv," 1848, p. 434.

Let me begin by noticing that Mimosa, in common with many other excitable plants, exhibits that remarkable phenomenon which we commonly call the sleep of plants, that is, that as night approaches the leaf-stalks sink, and the leaflets fold up, the whole leaf assuming a position closely resembling that which it assumes when it is irritated. All that time will allow me to say on this subject is that although the leaf assumes the same position in sleep as after excitation, the two effects are not identical. The state of sleep differs from that in which the plant finds itself after it has been irritated in two particulars. The first is, that in the state of sleep it is still excitable, and responds to stimulation exactly in the same way, although from being already depressed the extent of its motion is diminished; the other is, that in sleep, the joint, although bent downwards, is still more or less resistent and elastic; whereas in the unexcitable (or, what comes to the same thing *excited*) state, all elasticity has disappeared. In a word, in the motor organ of Mimosa, in common with all other excitable structures, the characteristic of the excited state is *limpness*. All the Mimosa plants on the table are in the state of sleep, but are still excitable, for when they are touched they sink to an even lower position than that of sleep, and at the same time become limp. Hence you have, as the result of excitation, two changes, namely (1), the change of position, only to be observed when the plant is awake, and (2) the loss of stiffness, dependent, as we shall see, on a vital change in the protoplasm of the cells, which is also observed when the plant is asleep.

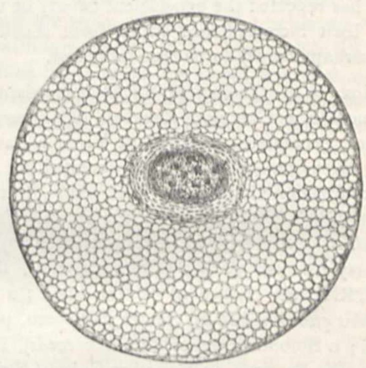


FIG. 2.—Section of the motor organ as projected on the screen. The vascular bundle in the middle of the section consists of a cylinder of thick-walled woody fibres and vessels, surrounded by a layer (annular in section) of elongated cells. The parenchyma is thicker below than above the vascular bundle. The section fails to show that the walls of the cells of the upper half have thicker walls.

So much for the general nature of the excitatory change. How do we discover what the mechanism is by which this remarkable organ of motion acts? By a mode of experiment which is well known to the physiologist. It may be called the method of ablation. We have here a mechanism which consists of several distinct parts, each, we may presume, having a distinct purpose; and the only method which will enable us to discover what these several purposes are is to observe how each acts alone—or, on the other hand, how the rest act after it has been taken away.

To prove that the motion of the whole leaf is dependent on the motor organ at the base of its stalk, requires no experiment. We see that the leaf descends, the joint bends, while the stalk remains rigid, and we know from its structure that the latter contains no mechanism by which it can act mechanically on the joint, as I act on my wrist by the muscles of my fore-arm.

The question therefore is—What part of the joint is essential? We begin by taking away the upper half, leaving the axial bundle and the lower half, and find that the leaf assumes a higher position than before. When touched, it falls. The function of the upper part, therefore, is merely auxiliary. The essential part is the lower, which in the unexcited state is capable of bearing the weight of the leaf. When it is excited it suddenly becomes weak, and the leaf falls. How does it do this? We will proceed to remove the axial bundle. The cellular cushion expands and lengthens, showing that it is elastic, and has a tendency to spring out when liberated. We have seen that this resistent cushion consists of cells, that is, of little

[1] Pfeffer, "Physiologische Untersuchungen," p. 9.

bladders, each of which is distended with liquid. And its tendency to expand as a whole is due to the tendency to expand of the innumerable cells of which it is made up. In the unmutilated state these are squeezed into a smaller space than that which they would assume if they were left to themselves; and, consequently, as their expansion is prevented, or curbed on one side, it acts on the opposite side, so as to bend the cylinder in the direction of the restraint.

All of this we can, perhaps, better understand by a model; and it is possible to make one which, not only in form but in principle, corresponds to the living mechanism it is intended to illustrate. In the model the axial bundle is represented by a strip of leather, the innumerable cells of the excitable cushion by an india-rubber bag. By a pump we are able to fill this cell or cushion more or less with fluid, and thus to vary its tension, and you see that if we increase the tension, the stem rises. By diminution it suddenly falls, just as the Mimosa leaf does when irritated.

We have come then to this point—that the reason why the leaf suddenly sinks on excitation is that the cells undergo a sudden diminution of tension or expansion. But our inquiry is not yet terminated. We have still to ask, How is this loss of tension effected? The answer is, by discharge of water. In the unexcited state all these cells are distended or charged with liquid. Suddenly, when the structure is excited, they let out or discharge that liquid, and it finds its way first into the intercellular air spaces, and secondly, out of the motor organ altogether. This we know to be a fact by an experiment of Pfeffer's, which must be regarded as one of the most important relating to the mechanism of plants that was ever made. He observed that if the leaf stalk is cut off from the motor organ, a drop of fluid appears at the cut surface at the moment that the latter bends downwards on excitation, and that in the experiment described just now, in which the upper part of the motor organ is cut off, there is also, so to speak, a sweating of liquid from the cut surface.

We are therefore certain that liquid escapes, but why does it escape? That I shall explain further on, and will now proceed to two other examples. One is a plant which is a great favourite in London, for it is one which flourishes even in London smoke —Mimulus. For our purpose it is good chiefly because its structure is very simple. It is one of those examples in which excitability is associated with the function of fertilisation, and inasmuch as this is a very transitory purpose, the property itself is transitory. When the cells of the stigmatic surface are touched they discharge their liquid contents, and consequently become limp. The outer layer of the lip is elastic, and tends to bend inwards. Consequently when the inner cells lose their elastic resilience it is able to act, and the lip bends inwards. In another allied plant, *Goldfussia anisophylla* (Fig. 3), which was described forty years ago by the Belgian naturalist Morren, we have the same mechanism. In this plant, as shown in the drawing, the style is not lipped but awl-shaped. It reaches to the mouth of the showy, orange-coloured corolla, to the inside of which it is united by its under surface. It has a smooth side, the epidermis of which is made up of numerous small prismatic cells, and is very elastic, and in the unexcited state concave, and a papillated side beset with the nipple-like ends of cylindrical cells, which, when unexcited, are distended with liquid. These cylindrical cells are continuous with those of the conducting tissue of the style. When an insect enters the flower, it does two things: it charges the fringe of hairs on the inside of the corolla with pollen, and touches the style, which, in consequence, bends suddenly in the opposite direction to that in which it was bent before, so as to plunge its stigmatic surface into the fringe. In this motion the epidermis acts as a spring simply. So long as the stigmatic tissue is turgid it cannot act. The moment its cells lose their tension, off it goes.[1]

Another plant investigated by Morren is one of very different organisation, but is one in which the existence of excitability has an equally plain teleological interpretation. Long ago Robert Brown, to whom plant-lore owes so much, when exploring the flora of Botany Bay, became acquainted with the now well-known Australian plant called Stylidium.[2] [A specimen from the Royal Gardens at Kew was exhibited.] Here is the plant (Fig. 4). The flower is too small to be easily seen, but the diagram will enable you to understand the mechanism. It has again to do with insects and fertilisation. In Stylidium the anthers and stigma are united together at the summit of a cylindrical stem which may be compared with the motor organ of Mimulus. You might naturally suppose that they were arranged so in order that the pollen from these anthers should be at once received by the adjoining stigmatic surface. That it is not so is evident from the order of development of the flower, for you find that at the moment that the anthers burst the stigma is not yet mature. Consequently the pollen is not intended for it, but for flowers which have come to maturity earlier, and the mechanism which now interests us fulfils this purpose. The figure shows the singular form of this strange flower. You observe that the column, as it is called, is bent down over the

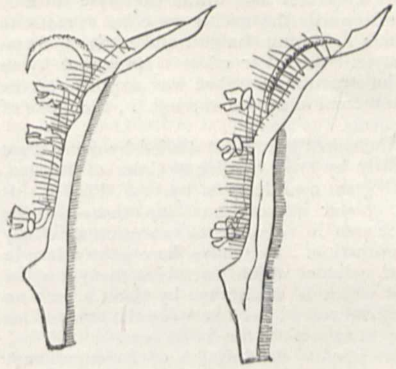


Fig. 3.

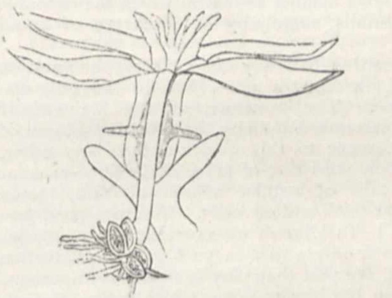


Fig. 4.

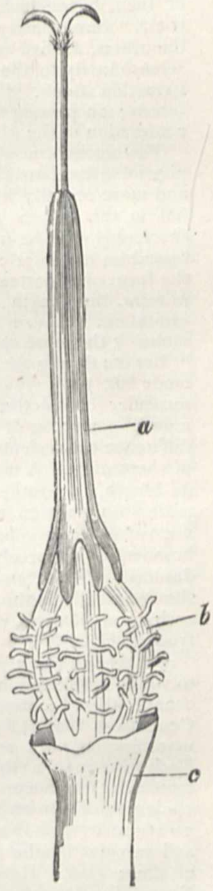


Fig. 5.

Fig. 3.—Style, stamens, and part of corolla of Goldfussia. In the left-hand figure the style is in the unexcited state, and is curved upwards, so that the stigmatic surface looks towards the mouth of the corolla. On excitation it suddenly assumes the position shown in the second figure, the stigma looking towards the roots of the collecting hairs.

Fig 4.—Flower of Stylidium, showing the column in the unexcited state, terminating in the anthers and stigma, which are surrounded by conspicuous hairs. It is bent down at the mouth of the corolla, the four principal lobes of which are seen, two on each side, and partly conceals the fifth lobe or labellum.

Fig. 5.—A floret of Centaurea as prepared for projection on the screen. The corolla (*c*) has been cut away so as to expose the five filaments (*b*), beset with hairs, and united above into the anther tube (*a*). The filaments are arched outwards, as in the unexcited state.

corolla so as to be in contact with the odd-looking labellum, which here takes the place of one of the petals. At the moment that the anthers burst the column attains its greatest sensitiveness. The slightest touch causes it to spring up, straighten itself suddenly, and then bend over to the opposite side. The mechanism resembles that of Mimosa and of Mimulus. There is a spring, the action of which is restrained by the resilience of cells distended with liquid. Suddenly these cells discharge their contents, and the spring acts.

And now let me pass to another group of plants which may serve as a contrast to Stylidium. Stylidium may be called an

[1] "Récherches sur le mouvement, &c., du style du Goldfussia anisophylla." *Mém. de l'Acad. Royale de Bruxelles.* 1839, vol. xii.

[2] Morren, "Recherches sur le mouvement et l'anatomie du *Stylidium graminifolium.*" *Mém. de l'Acad de Bruxelles*, t. xi., 1838.

out-of-the-way plant. It has an organisation which is not represented in the European flora. The family of thistles, and their allies the knapweeds (represented in our gardens by the ladies blue bottle), all of which are common wayside plants, exhibit excitable movements which, although of a very different kind from those we have just described, have, like them, to do with the visits of insects for the purpose of fertilisation. We will now throw on the screen a single fertile floret of *Centaurea Cyanus* (Fig. 5). The large diagram shows the same floret deprived of its corolla. Its axis is occupied by the style, surrounded by its tube of anthers. Below, the anther-filaments expand into a kind of cage, and again approach one another, when they are united with the tube of the corolla. At the moment that the anthers arrive at maturity these filaments are very excitable. When one of them is touched, it contracts and draws the style towards itself. Immediately afterwards the excitatory effect spreads to the others, all five arches becoming straight, and applying themselves closely to the style. A similar effect is produced by an induction shock. [The structure described was projected on the screen; on passing an induction current through it, the mode of contraction of the filaments was seen.]

The mechanism of Centaurea has been studied by many plant physiologists, particularly by Prof. Ferdinand Cohn of Breslau, and more recently with great completeness by Prof. Pfeffer. It has in this respect a greater interest than any other—that the shortening of these filaments in response to excitation strikingly resembles muscular contraction. You have here a structure in the form of a flattened cylinder which resembles many muscles in form, the length of which is diminished by about a sixth on excitation. This superficial resemblance between the two actions makes it the more easy to appreciate the differences.

Let me draw your attention to the diagram of an experiment made last year, which was intended to illustrate the nature of muscular contraction, and particularly to show that when a muscle contracts, it does not diminish in volume. The first difference between muscle and plant is a difference in the degree of shortening. A muscle shortens by something like a third of its length, the anther filament only by a sixth. But it is much more important to notice that in contracting, the filaments do not retain their volume. In shortening they broaden, but the broadening is scarcely measurable; hence they must necessarily diminish in bulk, and this shrinkage takes place, as Pfeffer has shown, exactly in the same manner as that in which the excitable cushion of Mimosa shrinks, namely by the discharge of liquid from its cells.

We are now in a position to study more closely the question to which I referred a few minutes ago—How do the cells discharge their contents? The structure of the filament of Centaurea, from its extreme simplicity, is a better subject of investigation with reference to this question, than any other. Each filament is a ribbon consisting of (1) a single fibro-vascular bundle, (2) delicate cells of regular cylindrical form, (3) an epidermis of somewhat thick-walled cells. [Microscopical preparations were shown.] In Mimosa we saw that the epidermis and vascular bundle took only a passive part in the production of the motion. Here, the part they play is even less important. Everything depends on the parenchyma, which, when excited, shrinks by discharging its water. Pfeffer proved this by cutting off the anther tube from the filaments, and then observing that on excitation a drop collected on the cut surface, which was reabsorbed as the filament again became arched. It is obvious that if the whole parenchyma discharges its liquid, each cell must do the same, for it is made up entirely of cells. To understand how each cell acts, we have only to consider its structure. Each consists of two parts—an external sac or vesicle, which is of cellulose, and, so long as the cell is in the natural or unexcited state, *over-distended*, so that, by virtue of its elasticity, it presses on the contents with considerable force; and secondly, of an internal more actively living membrane of protoplasm, of which the mechanical function is, so long as it is in its active condition, to charge itself fuller and fuller with liquid—the limit to further distension being the elastic envelope in which it is inclosed. In this way the two (the elastic envelope and the protoplasmic lining) are constantly in antagonism, the tendency of the former being towards discharge, that of the latter towards charge. This being so, our explanation of the effect of excitation on the individual cell amounts to this—that the envelope undergoes no change whatever, but that the protoplasm lining suddenly loses its water-absorbing power, so that the elastic force of the envelope at once comes into play and squeezes out the cell-contents. Consequently, although here, as everywhere, the protoplasm is the seat of the primary change, the mechanical agent of the motion is not the protoplasm, but the elastic envelope in which it is inclosed.

(*To be continued.*)

ELECTRIC LIGHTING BY INCANDESCENCE[1]

SPEAKING in this place on electric light, I can neither forget nor forbear to mention, as inseparably associated with the subject and with the Royal Institution, the familiar, illustrious, names of Davy and Faraday. It was in connection with this institution that, eighty years ago, the first electric light experiments were made by Davy, and it was also in connection with this Institution that, forty years later, the foundations of the methods, by means of which electric lighting has been made useful, were strongly laid by Faraday.

I do not propose to describe at any length the method of Davy, I must, however, describe it slightly, if only to make clear the difference between it and the newer method which I wish more particularly to bring under your notice.

The method of Davy consists, as almost all of you know, in producing electrically a stream of white-hot gas between two pieces of carbon.

When electric light is produced in this manner, the conditions which surround the process are such as render it impossible to obtain a small light with proportionally small expenditure of power. In order to sustain the arc in a state approaching stability, a high electromotive force and a strong current are necessary; in fact, such electromotive force and such current as correspond to the production of a luminous centre of at least several hundred candle-power. When an attempt is made to produce a smaller centre of light by the employment of a proportionally small amount of electrical energy, the mechanical difficulties of maintaining a stable arc, and the diminution in the amount of light (far beyond the diminished power employed), puts a stop to reduction at a point at which much too large a light is produced for common purposes.

The often-repeated question, "Will electricity supersede gas?" could be promptly answered if we were confined to this method of producing electric light; and for the simple reason that it is impossible, by this method, to produce individual lights of moderate power.

The electric arc does very well for street lighting, as you all know from what is to be seen in the City. It also does very well for the illumination of such large inclosed spaces as railway stations; but it is totally unsuited for domestic lighting, and for nine-tenths of the other purposes for which artificial light is required. If electricity is to compete successfully with gas in the general field of artificial lighting, it is necessary to find some other means of obtaining light through its agency than that with which we have hitherto been familiar. Our hope centres in the method—I will not say, the *new* method—but the method which until within the last few years has not been applied with entire success, but which, within a recent period, has been rendered perfectly practicable—I mean the method of producing light *by electrical incandescence.*

The fate of electricity as an agent for the production of artificial light in substitution for gas, depends greatly on the success or non-success of this method; for it is the only one yet discovered which adapts itself with anything like completeness to all the purposes for which artificial lighting is required.

If we are able to produce light *economically* through the medium of *electrical incandescence*, in small quantities, or in large quantities, as it may be required, and at a cost not exceeding the cost of the same amount of gas-light, then there can be little doubt—there can, I think, be *no* doubt—that in such a form, electric light has a great future before it. I propose, therefore, to explain the principle of this method of *lighting by incandescence* to show *how it can be applied*, and to discuss the question of *its cost.*

When an electrical current traverses a conducting wire, a certain amount of *resistance* is opposed to the passage of the current. One of the effects of this conflict of forces is the development of heat. The amount of heat so developed depends on the nature of the wire—on its length and thickness, and on the strength of the current which it carries. If the wire be thin and the current strong, the heat developed in it may be so great as to raise it to a white heat.

[1] Lecture delivered at the Royal Institution of Great Britain, March 10, 1882, by Joseph W. Swan, Sir Frederick Bramwell, F.R.S., vice-president, in the chair.

The experiment I have just shown illustrates the principle of electric lighting by incandescence, which is briefly this—that a *state of white heat may be produced in a continuous solid conductor by passing a sufficiently strong electrical current through it.*

A principle, the importance of which cannot well be over-estimated, underlies this method of producing light electrically—namely, the principle of *divisibility.* By means of electric incandescence it is possible to produce exceedingly small centres of light, even so small as the light of a single candle; and with no greater expenditure of power in proportion to the light produced, than is involved in the maintenance of light-centres 10 or 100 times greater. Given a certain kind of wire, for example a platinum wire, the 100th of an inch in diameter, a certain quantity of current would make this wire white-hot whatever its length. If in one case the wire were one inch long and in another case ten inches long, the same current passing through these two pieces of similar wire, would heat both to precisely the same temperature. But in order to force the same current through the ten times longer piece, ten times the electromotive force, or, if I may be allowed the expression, electrical pressure, is required, and exactly ten times the amount of energy would be expended in producing this increased electro-motive force.

Considering, therefore, the proportion between power applied and light produced, there is neither gain nor loss in heating these different lengths of wire. In the case of the longer wire, as it had ten times the extent of surface, ten times more light was radiated from it than from the shorter wire, and that is exactly equivalent to the proportional amount of power absorbed. It is therefore evident that *whether a short piece of wire or a long piece is electrically heated, the amount of light produced is exactly proportional to the power expended in producing it.*

This is extremely important; for not only does it make it possible to produce a small light where a small light is required, without having to pay for it at a higher rate than for a larger light, but it gives also the great advantage of obtaining *equal distribution* of light. As the illuminating effect of light is inversely as the square of the distance of its source, it follows that where a large space is to be lighted, if the lighting is accomplished by means of centres of light of great power, a much larger total quantity of light has to be employed, in order to make the spaces remotest from these centres sufficiently light, than would be required if the illumination of the space were obtained by numerous smaller lights equally distributed.

In order to practically apply the principle of producing light by the incandescence of an electrically heated continuous solid conductor, it is necessary to select for the light-giving body a material which offers a considerable *resistance* to the passage of the electric current, and which is also capable of bearing an exceedingly high temperature without undergoing fusion or other change.

As an illustration of the difference that exists among different substances in respect of *resistance* to the flow of an electric current, and consequent tendency to become heated in the act of electrical transmission, here is a wire formed in alternate sections of platinum and silver; the wire is perfectly uniform in diameter, and when I pass an electric current through it, although the current is uniform in every part, yet, as you see, the wire is not uniformly hot, but white-hot only in parts. The white-hot sections are platinum, the dark sections are silver. Platinum offers a higher degree of resistance to the passage of the electric current than silver, and in consequence of this, more heat is developed in the platinum than in the silver sections.

The high electrical resistance of platinum, and its high melting-point, mark it out as one of the most likely of the metals to be useful in the construction of incandescent lamps. When platinum is mixed with 10 or 20 per cent. of iridium, an alloy is formed, which has a much higher melting-point than platinum; and many attempts have been made to employ this alloy in electric lamps. But these attempts have not been successful, chiefly because, high as is the melting-point of iridio-platinum, it is not high enough to allow of its being heated to a degree that would yield a sufficiently large return in light for energy expended. Before an economical temperature is reached, iridio-platinum wire slowly volatilises and breaks. This is a fatal fault, because *in obtaining light by incandescence there is the greatest imaginable advantage in being able to heat the incandescing body to an extremely high temperature.* I will illustrate this by experiment.

Here is a glass bulb containing a filament of carbon. When I pass through the filament *one unit* of current, light equal to *two candles* is produced. If now I increase the current by *one-half,* making it *one unit and a half,* the limit is increased to *thirty candles,* or thereabout, so that for this one-half increase of current (which involves nearly a *doubling of the energy* expended), *fifteen times more light* is produced.

It will readily be understood from what I have shown that it is essential to economy that the incandescing material should be able to bear an enormous temperature without fusion. We know of no metal that fulfils this requirement; but there is a non-metallic substance which does so in an eminent degree, and which also possesses another quality, that of *low conductivity.* The substance is carbon. In attempting to utilise carbon for the purpose in question, there are several serious practical difficulties to be overcome. There is, in the first place, the mechanical difficulty arising from its intractability. Carbon, as we commonly know it, is a brittle and non-elastic substance, possessing neither ductility nor plasticity to favour its being shaped suitably for use in an electric lamp. Yet, in order to render it serviceable for this purpose, it is necessary to form it into a slender filament, which must possess sufficient strength and elasticity to allow of its being firmly attached to conducting-wires, and to prevent its breaking. If heated white hot in the air, carbon burns away; and therefore means must be found for preventing its combustion. It must either be placed in an atmosphere of some inert gas or in a vacuum.

During the last forty years, spasmodic efforts have from time to time been made to grapple with the many difficulties which surround the use of carbon as the wick of an electric lamp. It is only within the last three or four years that these difficulties can be said to have been surmounted. It is now found that carbon can be produced in the form of straight or bent filaments of extreme thinness, and possessing a great degree of elasticity and strength. Such filaments can be produced in various ways—by the carbonisation of paper, thread, and fibrous woods and grasses. Excellent carbon filaments can be produced from the bamboo, and also from cotton thread treated with sulphuric acid. The sulphuric acid treatment effects a change in the cotton thread similar to that which is effected in paper in the process of making parchment paper. In carbonising these materials, it is of course necessary to preserve them from contact with the air. This is done by surrounding them with charcoal.

Here is an example of a carbon filament produced from parchmentised cotton thread. The filament is not more than the ·01 of an inch in diameter, and yet a length of three inches, having therefore a surface of nearly the one-tenth of an inch, gives a light of twenty candles when made incandescent to a moderate degree.

I have said, that, in order to preserve these slender carbon filaments from combustion, they must be placed in a vacuum; and experience has shown that if the filaments are to be durable, the vacuum must be exceptionally good. One of the chief causes of failure of the earlier attempts to utilise the incandescence of carbon, was the imperfection of the vacua in which the white-hot filaments were placed; and the success which has recently been obtained is in great measure due to the production of a better vacuum in the lamps.

In the primitive lamps, the glass shade or globe which enclosed the carbon filament was large, and usually had screw joints, with leather or india-rubber washers. The vacuum was made either by filling the lamp with mercury, and then running the mercury out so as to leave a vacuum like that at the upper end of a barometer, or the air was exhausted by a common air pump. The invention of the mercury pump by Dr. Sprengel, and the publication of the delicate and beautiful experiments of Mr. Crookes in connection with the radiometer, revealed the conditions under which a really high vacuum could be produced, and in fact gave quite a new meaning to the word vacuum. It was evident that the old incandescent lamp experiments had not been made under suitable conditions as to vacuum; and that before condemning the use of carbon, its durability in a really high vacuum required still to be tested. This idea having occurred to me, I communicated it to Mr. Stearn, who was working on the subject of high vacua, and asked his co-operation in a course of experiments having for their object to ascertain whether a carbon filament produced by the carbonisation of paper, and made incandescent in a high vacuum was durable. After much experimenting we arrived at the conclusion that *when a well-formed carbon filament is firmly connected with conducting wires, and placed in a hermeti-*

cally sealed glass ball, perfectly exhausted, the filament suffers no apparent change even when heated to an extreme degree of whiteness. This result was reached in 1878. It has since then become clearly evident that Mr. Edison had the same idea and reached the same conclusion as Mr. Stearn and myself.

A necessary condition of the higher vacuum was the simplification of the lamp. In its construction there must be as little as possible of *any* material, and there must be none of such material as could occlude gas, which being eventually given out would spoil the vacuum. There must besides be no joints except those made by the glass-blower.

Therefore, naturally and per force of circumstances, the incandescent carbon lamp took the most elementary form, resolving itself into a *simple bulb, pierced by two platinum wires supporting a filament of carbon.* Probably the first lamp, having this elementary character, ever publicly exhibited, was shown in operation at a meeting of the Literary and Philosophical Society of Newcastle in February, 1879. The vacuum had been produced by Mr. Stearn by means of an improved Sprengel pump of his invention.

Blackening of the lamp glass, and speedy breaking of the carbons, had been such invariable accompaniments of the old conditions of imperfect vacua, and of imperfect contact between carbon and conducting wires, as to have led to the conclusion that the carbon was volatilised. But under the new conditions these faults entirely disappeared; and carefully conducted experiments have shown that well-made lamps are quite serviceable after more than a thousand hours' continual use.

Here are some specimens of the latest and most perfected forms of lamp. The mode of attaching the filament to the conducting wires by means of a tiny tube of platinum, and also the improved form of the lamp, are due to the skill of Mr. Gimmingham.

The lamp is easily attached and detached from the socket which connects it with the conducting wires; and can be adapted to a great variety of fittings, and these may be provided with switches or taps for lighting or extinguishing the lamps. I have here a lamp fitted especially for use in mines. The current may be supplied either through main wires from a dynamo-electrical machine, with flexible branch wires to the lamp, or it may be fed by a set of portable store cells closely connected with it. I will give you an illustration of the *quality* of the light these incandescent lamps are capable of producing by turning the current from a Siemens' dynamo-electric machine (which is working by means of a gas engine in the basement of the building) through sixty lamps ranged round the front of the gallery and through six on the table. (The theatre was now completely illuminated by means of the lamps, the gas being turned off during the rest of the lecture.)

It is evident by the appearance of the flowers on the table that colours are seen very truly by this light, and this is suggestive of its suitability for the lighting of pictures.

The heat produced is comparatively very small; and of course there are no noxious vapours.

And now I may, I think, fairly say that the difficulties encountered in the construction of incandescent electric lamps have been completely conquered, and that their use is *economically practicable.* In making this statement I mean, that, both as regards the *cost of the lamp* itself and *the cost of supplying electricity to illuminate it,* light can be produced at a cost which will compare not unfavourably with the cost of gas light. It is evident that if this opinion can be sustained, lighting by electricity at once assumes a position of the widest public interest, and of the greatest economic importance; and in view of this, I may be permitted to enter with some detail into a consideration of the facts which support it.

There has now been sufficient experience in the manufacture of lamps to leave no doubt that they can be cheaply constructed, and we know by actual experiment that continuous heating to a fairly high degree of incandescence during 1200 hours does not destroy a well-made lamp. What the utmost limit of a lamp's life may be we really do not know. Probably it will be an ever-increasing span; as, with increasing experience, processes of manufacture are sure to become more and more perfect. Taking it, therefore, as fully established that *a cheap and durable lamp can now be made,* the further question is as to *the cost of the means of its illumination.*

This question in its simplest form is that of the more or less economical use of coal; for coal is the principal raw material alike in the production of gas and of electric light. In the one case, the coal is consumed in producing gas which is burnt; in the other in producing motive power, and, by its means, electricity.

The cost of producing light by means of electric incandescence may be compared with the cost of producing gas-light in this way—2 cwt. of coal produces 1000 cubic feet of gas, and this quantity of gas, of the quality called fifteen-candle gas, will produce 3000 candle-light for one hour. But besides the product of gas, the coal yields certain bye-products of almost equal value. I will, therefore, take it that we have in effect 1000 feet of gas from 1 cwt. of coal instead of from 2, as is actually the case.

And now, as regards the production of electricity. One cwt. of coal—that is the same measure *in point of value* as gives 1000 feet of gas—will give 50 horse-power for one hour. Repeated and reliable experiments show that we can obtain through the medium of incandescent lamps at least 200 candle-light per horse-power per hour. But as there is waste in the conversion of motive power into electricity, and also in the conducting-wires, let us make a liberal deduction of 25 per cent., and take only 150 candle-light as the nett available product of 1 horse-power; then for 50 horse-power (the product of 1 cwt. of coal), we have 7500 candle-light, as against 3000 candle-light from *an equivalent value* of gas. That is to say, two and a half times more light.

There still remains an allowance to be made to cover the cost of the renewal of lamps. There is a parallel expense in connection with gas lighting in the cost of the renewal of gas-burners, gas globes, gas chimnies, &c. I cannot say that I think these charges against gas-lighting will equal the corresponding charges against electric lighting, unless we import into the account—as I think it right to do—the consideration that, without a good deal of expense be incurred in the renewal of burners, and unless minute attention be given, far beyond what is actually given, to all the conditions under which the gas is burned, nothing like the full light product which I have allowed to be obtainable from the burning of 1000 cubic feet of gas, will be obtained, and, as a matter of fact, is not commonly obtained, especially in domestic lighting. Taking this into account, and considering what would have to be done to obtain the full yield of light from gas, and that if it be not done, then the estimate I have made is too favourable, I think but little, if any, greater allowance need be made for the charge in connection with the renewal of lamps in electric lighting than ought to be made for the corresponding charges for the renewal of gas-burners, globes, chimneys, &c. But it will be seen that even if the cost for renewal of lamps should prove to be considerably greater than the corresponding expense in the case of gas, there is a wide margin to meet them before we have reached the limit of the cost of gas-lighting.

I think too it must be fairly taken into account and placed to the credit of electric lighting, that by this mode of lighting there is entire avoidance of the damage to furnishings and decorations of houses, to books, pictures, and to goods in shops, which is caused through lighting by gas, and which entails a large expenditure for repair, and a large amount of loss which is irreparable.

I have based these computations of cost of electric light on the supposition that the light product of 1 horse-power is 150 candles. But if durability of the lamps had not to be considered, and it were an abstract question how much light can be obtained through the medium of an incandescent filament of carbon, then one might, without deviating from ascertained fact, have spoken of a very much larger amount of light as obtainable by this expenditure of motive power. I might have assumed double or even more than double the light for this expenditure. Certainly double and treble the result I have supposed can actually be obtained. The figures I have taken are those which consist with long life to the lamps. If we take more light for a given expenditure of power, we shall have to renew the lamps oftener, and so what we gain in one way we lose in another. But it is extremely probable that a higher degree of incandescence than that on which I have based my calculations of cost, may prove to be compatible with durability of the lamps. In that case, the economy of electric lighting will be greater than I have stated.

In comparing the cost of producing light by gas and by electricity, I have only dealt with the radical item of coal in both cases. Gas-lighting is entirely dependent upon coal—electric lighting is not, but in all probability coal will be the chief source of energy in the electric lighting also. When, however, water power is available, electric lighting is in a position of still greater advantage, and, in point of cost, altogether beyond comparison with other means of producing light.

To complete the comparison between the cost of electric light and gas light, we must consider not only the amount of coal required to yield a certain product of light in the one case and in the other, but also the cost of converting the coal into electric current and into gas; that is to say, the cost of manufacture of electricity and the cost of manufacture of gas. I cannot speak with the same exactness of detail on this point as I did on the comparative cost of the raw material. But if you consider the nature of the process of gas manufacture, and that it is a process, in so far as the lifting of coal by manual labour is concerned, not very unlike the stoking of a steam boiler, and if electricity is generated by means of steam, then the manual labour chiefly involved in both processes is not unlike. It is evident that in gas manufacture it would be necessary to shovel into the furnaces and retorts five or six times as much coal to yield the same light product as would be obtainable through the steam engine and incandescent lamps. But here again it is necessary to allow for the value of the labour in connection with the products other than gas, and hence it is right to cut down the difference I have mentioned to half—*i.e.* debit gas with only half the cost of manufacture, in the same way as in our calculation we have charged gas with only one-half the coal actually used. But when that is done there is still a difference of probably three to one in respect of labour in favour of electric lighting.

I have made these large allowances of material and labour in favour of the cost of gas, but it is well known that the bye products are but rarely of the value I have assumed. I desire, however, to allow all that can be claimed for gas.

With regard to the COST OF PLANT, I think there will be a more even balance in the two cases. In a gasworks you have retorts and furnaces, purifying chambers and gasometers, engines, boilers, and appliances for distributing the gas and regulating its pressure. Plant for generating electricity on a large scale would consist principally of boilers, steam-engines, dynamo-electric machines, and batteries for storage.

No such electrical station, on the scale and in the complete form I am supposing, has yet been put into actual operation; but several small stations for the manufacture of electricity already exist in England, and a large station designed by Mr. Edison is, if I am rightly informed, almost completed in America. We are therefore on the point of ascertaining by actual experience, what the *cost of the works* for generating electricity will be. Meanwhile, we know precisely the cost of boilers and engines, and we know approximately what ought to be the cost of dynamo-electric machines of suitably large size. We have, therefore, sufficient grounds for concluding that to produce a given quantity of light electrically the cost of plant would not exceed greatly, if at all, the cost of equivalent gas-plant.

There remains to be considered, in connection with this part of the subject, the *cost of distribution*. Can electricity be distributed as widely and cheaply as gas? On one condition, which I fully hope can be complied with, this may be answered in the affirmative. The condition is that it may be found practicable and safe to distribute electricity of comparatively high tension.

The importance of this condition will be understood when it is remembered that to effectively utilise electricity in the production of light in the manner I have been explaining, it is necessary that the *resistance in the carbon of the lamps* should be relatively great to the *resistance in the wires which convey the current to them*. When lamps are so united with the conducting wire, that the current which it conveys is divided amongst them, you have a condition of things in which the aggregate resistance of the lamps will be very small, and the conducting wire, to have a relatively small resistance, must either be *very short*, or, if it be long, it must be *very thick*, otherwise there will be excessive waste of energy; in fact, it will not be a practical condition of things.

In order to supply the current to the lamps economically, there should be comparatively little resistance in the line. A waste of energy through the resistance of the wire of 10 or perhaps 20 per cent. might be allowable, but if the current is supplied to the lamps in the manner I have described—that of *multiple arc*, each lamp being as it were *a crossing between two main wires*, then—and even if the individual lamps offered a somewhat higher degree of resistance than the lamps now in actual use—the thickness of the conductor would become excessive if the line was far extended. In a line of half a mile, for instance, the weight of copper in the conductor would become so great, in proportion to the number of lamps supplied through it, as to be a serious charge on the light. On the other hand, if a smaller conducting wire were used, the waste of energy and consequent cost would greatly exceed that I have mentioned as the permissive limit.

Distribution in this manner has the merit of simplicity, it involves no danger to life from accidental shock; and it does not demand great care in the insulation of the conductor. But it has the great defect of limiting within comparatively small bounds the area over which the power for lighting could be distributed from one centre. In order to light a large town electrically on this system, it would be necessary to have a number of supply stations, perhaps half a mile or a mile apart. It is evidently desirable to be able to effect a wider distribution than this, and I hope that either by arranging the lamps *in series*, so that the same current passes through several lamps in succession, or by means of *secondary voltaic cells*, placed as electric reservoirs in each house, it may be possible to economically obtain a much wider distribution.

Whether by the method of multiple arc (illustrated by Diagram I.) which necessitates the multiplication of electrical stations; or by means of the simple series (illustrated by Diagram II.), or by means of secondary batteries connected with each other from house to house in single series, the lamps being fed from these in multiple arc (as illustrated by Diagram III.), I am quite satisfied that comparatively with the distribution of gas, the distribution of electricity is sufficiently economical to permit of its practical application on a large scale.

As to the cost of laying wires in a house, I have it on the authority of Sir Wm. Thomson, who has just had his house completely fitted with incandescent lamps from attics to cellars—to the entire banishment of gas—that the cost of internal wires for the electric lamps is less than the cost of plumbing in connection with gas-pipes.

I have expended an amount of time on the question of *cost* which I fear must have been tedious; but I have done so from the conviction that the practical interest of the matter depends on this point. If electric lighting by incandescence is not an economical process, it is unimportant; but if it can be established—and I have no doubt that it can—that this mode of producing light is economical, the subject assumes an aspect of the greatest importance.

Although at the present moment there may be deficiencies in the apparatus for generating and storing electricity on a very large scale, and but little experience in distributing it for lighting purposes over wide areas, and consequently much yet to be learnt in these respects; yet, if once it can be clearly established that, light for light, electricity is as cheap as gas, and that it can be made applicable to all the purposes for which artificial light is required, electric light possesses such marked advantages in connection with health, with the preservation of property, and in respect of safety, as to leave it as nearly certain as anything in this world can be, that the wide substitution of the one form of light for the other is only a question of time.

SCIENTIFIC SERIALS

Bulletin de l'Academie Royale des Sciences de Belgique, No. 6. —Resistance of the air in guns; letter by M. Colladon.—Note on experimental ballistics, by M. Melsens.—Experimental rearches on the respiratory movements of insects, by M. Plateau. —Existence and amount of diurnal precession and nutation, on the hypothesis of a solid earth, by M. Folie.—Fundamental principle relative to contact of two surfaces having a common generatrix, by M. Mansion.—On a geometrical representation of two uniform transformations, by M. Le Paige.—On bibrominated camphor, by M. Swarts.—Action of trichloride and tribromide of phosphorus on gaseous phosphuretted hydrogen, by M. de Wilde.—Action of trichloride of phosphorus on iodide of phosphonium, by the same.—Researches on the structure and signification of the respiratory apparatus of Arachnida, by Mr. MacLeod.

Annalen der Physik und Chemie, No. 8.—On development of electricity as equivalent of chemical processes, by F. Braun.—The theory of the micro-telephone, by V. Wietlisbach.—On prism-observation with obliquely-incident light, and on a modification of the Wollaston method of determination for relations of light-refraction, by F. Kohlrausch.—On the setting of an object in the total-reflectometer, by the same.—On the tensions of saturated mercury-vapour at low temperatures, by E. B. Hagen.—On determination of the constants of internal friction of gases and liquids, by means of oscillating discs, by L. Grossmann.—Determination of the friction of liquids by Maxwell's method, by Th. S. Schmidt.—Researches on the volume-constitution of liquid compounds, by H. Schröder.—On the phosphates of thallium and lithium, by C. Rammelsberg.—On potassium-dithallium-chloride, by the same.—On the electricity of flames (corrections), by J. Elster and H. Geitel.

Atti della R. Accademia dei Lincei. Transunti, vol. vi. fasc. 13.—On Italian emigration in 1881 compared with that of the five previous years, and with the emigration from other States of Europe, by S. Bodie.

SOCIETIES AND ACADEMIES

LONDON

Royal Horticultural Society, July 25.—Sir J. D. Hooker in the chair.—*Hybrid Tacsonia:* Dr. Masters exhibited a blossom of a hybrid between *T. exoniensis* (itself a hybrid) and *Vochsiemi.* —*Rhododendron camellii florum:* Mr. Mangles exhibited a spray of this late-flowering species, which resembled a tea in flower. It bore only one flower instead of two together, as described by Hooker; and he suggested it might be identical with *R. sparsiflorum*, Booth, of Bhotan. In foliage it agrees with *R. Maddeni.* —*Hollyhock disease:* Mr. W. G. Smith gave an account of his planting healthy seeds of the hollyhock and others affected with Puccinia. He planted twenty tainted seeds, one of two only which germinated, survived. This one appears to be quite unaffected. Of fifty healthy seeds, all germinated. After the third week, leaves of common mallow diseased with Puccinia were scattered amongst them. In less than a week forty-six of the seedlings died of the disease.—*Rhododendron hybrids:* Mr. Veitch sent blossoms of seedlings of a hybrid, to show interesting deviations, a slightly double flower having been artificially "self-fertilised," twenty seedlings were raised from it. Of these five have blossomed, as follows: a deep rose, a double white, a semi-double yellow, a salmon, and a semi-double rose. The remarkable features about them are that white crossed by orange gives pink, the yellow being eliminated, and that a rudimentary calyx appears on these seedlings, *R. Jasminiflorum*, one of the original parents, having none.—Mr. Henslow remarked on the general tendency to suppress a calyx in flowers, which are small and massed together, as in Rubiaceæ, Caprifoliaceæ, Umbelliferæ, &c., and suggested that its re-appearance was correlated to the enlarged corolla, and less "massing" of the truss than occurs in *R. Jasminiflorum.*

PARIS

Academy of Sciences, July 31.—M. Jamin in the chair.—The following papers were read:—On the period of variable state which precedes the *régime* of detonation, and on the conditions of establishment of the explosive wave, by MM. Berthelot and Vieille. They recorded on a rotating cylinder, the spark causing the initial inflammation at the entrance of the tube, and the displacement of a very light piston moving freely in the tube at the other end. They study the velocities, the corresponding pressures, and the limits of detonation.—Additional note on the rapid solution of the problem of Kepler, by M. Zenger.—Auxiliary tables for calculating the true anomaly of planets, by the same.—On some theorems of electricity, demonstrated in an inexact way in didactic works, by M. Machai.—On the longitudinal vibrations of elastic wires whose ends are submitted to any strains, by MM. Sebert and Hugoniot.—On the electric resistance of glass at low temperatures, by M. Foussereau. Using ordinary glass with base of soda and lime, Bohemian glass and crystal, the electric conductivity was found to rise rapidly with the temperature. The method is described, and formulæ are given.—On the flow of sound in pipes, by M. Neyreneuf. With a sensitive flame, from a burner like the Bunsen, but having, instead of the lower air holes, one small lateral orifice at about two-thirds of the height, he measured the intensity of a sound (from strokes of a bell) that had traversed tubes of different length and diameter, watching at what distance from the mouth of the tube the flame became insensible. He obtains a formula representing the law.—On the heat of dissolution of some mixtures, by M. Chroustchoff.—Action of ammonia on oxide of copper, by M. Maumené.—On the composition of *vins de marc*, by M. Girard. This name he applies to wines from fermentation of sugar in presence of the residua of vintage. He says they have a pretty regular composition, and have alimentary and hygienic qualities equivalent to two-thirds to half those of ordinary wines.—On the ethers of glycol, $C_{22}H_{14}O_2$, by M. Rousseau.—Preparations of acetylcyanacetic ether and some of its metallic derivatives, by MM. Haller and Held.—On the conditions of formation of rosanilines, by MM. Rosenstiehl and Gerber.—On a new use of electrolysis in dyeing and printing, by M. Goppelsrœder. For example, he impregnates tissues or paper with an aqueous solution of chlorhydrate of aniline, puts it on a non-attackable metal plate, which he connects with one pole of a battery or small dynamo. On the tissue or paper is placed a second metal plate having a design in relief and joined to the other pole; on pressure and passage of the current the design is reproduced. A modification of the method gives chemical discharge of colour. The current, again, is used to prepare vats of indigo, aniline black, &c.; the hydrogen which arises at the negative pole being utilised. It is also used to prevent oxidation of colours in printing.—On the formation and decomposition of acetanilide, by M. Menschutkin.—On the products of distillation of colophany, by M. Renard.—On *Crenothrix Kühniana* (Rabenhorst), cause of infection of the waters of Lille, by M. Giard. This gives an iron red scum in the water of the Emmerin springs supplying the town. The evil has been very pronounced this spring. Rains bring it on; engaging these small organisms, that quickly develop in the moist earth prepared by dejections from distilleries, &c.—Structure of the nervous systems of molluscs, by M. Viguel.—On the male sexual organs and the Cuvier organs of Holothurians, by M. Jourdain.—Researches on the production of monstres, in the hen's egg, by means of slow incubation, by M. Dareste.—On sexuality in the ordinary system (*O. Edulis*), and in the Portuguese system (*O. Angulata*); Artificial fecundation of the latter, by M. Bouchon-Brandely.—On the properties of antiseptics, and volatile products of putrefaction, by M. Le Bon. The disinfectant power of any antiseptic is weaker the older the putrefaction. The strongest disinfectants are permanganate of potash, chloride of lime, sulphate of iron acidified with acetic acid, carbolic acid, and the glyceroborates of sodium and potassium. There is no parallelism between disinfectant action of an antiseptic and its action on microbes; nor between the power of preventing putrefaction and that of stopping it when it has begun. Except a very few substances, strongly poisonous (such as bichloride of mercury), most antiseptics, and notably carbolic acid, have very little action on bacteria. There is no parallelism between the virulent power of a substance in putrefaction and the toxical power of volatile compounds liberated from it. The volatile alkaloids from advanced putrefaction are very poisonous. The air of cemeteries may be very dangerous.—On an observation of diffuse lightning, by M. Rousseau.

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