THURSDAY, MAY 13, 1880

MIGRATORY BIRDS AT LIGHTHOUSES

CONSIDERING the amount of nonsense that has been written and still continues to be written—in season and out of season—on the subject of the migration of birds, it is very refreshing to find two gentlemen in this country seriously setting to work to accumulate facts, which may in time be reasonably expected to enable ornithologists to arrive at an opinion, more decided than anybody can be said to possess at the present moment, with regard to that wonderful movement. It might be thought, perhaps, that we indeed had already enough and to spare of recorded observations, for lists of the arrival of migratory birds abound in most of our natural-history periodicals, to say nothing of provincial newspapers; but it does not require much study and comparison of those lists to perceive that, with some honourable exceptions, they are obviously the work of persons not at all fitted—whether by character, training, or opportunities it matters not—to be competent observers, and consequently the records of their observations have done uncommonly little to advance our knowledge of the subject. Every one who has tried anything of the sort must admit, if he speaks the truth, that the difficulties in the way of observing the movements of birds are much greater than at first sight would appear to be the case. To carry on this kind of systematic observation to any good purpose, a man, if he cannot make it his first object, must yet have such occupations as will not interfere with his being in the right place at the right moment, and of course the ordinary engagements of life are very apt to act as disturbing forces and to baffle his best intentions. Farmers, in the pursuit of their vocation, are perhaps of all professional men the most suited for the work; but the farmer may have to attend a couple of distant market-towns for as many days in the week, and unless his road thither and thence lies favourably, these will be *dies non* so far as his opportunities of observation are concerned. A very few years' experience will convince any sensible person that the first wheatear of the season is almost always to be seen on a certain down or heath, and the earliest swallow over a certain pool or reach of a river. Localities like these, once discovered, have to be watched daily by him who wishes to record faithfully the arrival in his district of those particular species, and the same is to be said of others. Even the most enthusiastic sportsman may be hindered by a score of circumstances over which he has no control from visiting for a week or more the particular spot in a copse or corner of a bog where, if there be a woodcock or a snipe in the country, he knows it is sure to be found. Seeing then that of the various kinds of outdoor observations few are more subject to the accidents which affect human actions and habits than those which relate to the movements of birds, the extremely unsatisfactory nature of records made in what is at best a casual way may be accounted for, and hitherto we have had scarcely any records of any other sort.

Some time ago it occurred to Mr. Cordeaux, author of that excellent little book "The Birds of the Humber District," noticed in these columns some seven or eight years since (NATURE, vol. viii. p. 100), and to Mr. Harvie Brown, a gentleman not less well known by his ornithological writings, that a great increase in our knowledge of the subject would accrue if they could but get the keepers of the numerous lighthouses and lightships along our coast to assist in the work, and accordingly they set about enlisting these men in the service.[1] We know not whether these gentlemen had fully appreciated the unsatisfactory nature of existing records, upon which we have just been dwelling, nor does it signify in the least. It was evident to them, and might have been to others, that men who were always on duty and always on the look-out would be able, if so minded and properly instructed, to give valuable aid, and that their observations would necessarily be of a kind that it was impossible for any other class of people to make, for they would be carried on at hours when nearly all the rest of the world was indoors, if not asleep, and at places at once the most favourable and the most inaccessible to any one else.

By what steps Messrs. Cordeaux and Brown proceeded, and how they overcame the scruples (if any were entertained) of the authorities of the Trinity House Board in England and of the Commissioners of Northern Lights in Scotland, we are not told; but these gentlemen have to be congratulated on the result they have attained, which appears in the form of a most instructive and interesting "Report"—the first, we hope, of a long series—"on the Migration of Birds in the Autumn of 1879," printed in the *Zoologist* for the current month, to which we beg leave to call our readers' best attention. It appears that forms of inquiry and letters of instruction were sent to various lighthouses and lightships. To begin with the east coast of Great Britain, it is said that such papers were forwarded to *twenty-six* Scottish lighthouses, from *thirteen*, or just one-half, of which returns have been received, the remaining thirteen having either sent back the forms blank, owing to the unusual scarcity of birds last autumn, or having taken no notice of the request to fill them up. The same course was pursued with respect to *thirty-seven* English stations, from *twenty-five* of which returns have been received. On the west coast appeal was made to *thirty-four* Scottish stations, *twenty-four* of which replied, and to three on the Isle of Man (the Manxmen were silent), but to none in England or Wales. So much willing co-operation, we confess, we could hardly have anticipated, especially on a first experiment, and it certainly appears from the intelligent remarks (of which specimens are occasionally given by the reporters), in addition to the mere filling up of the sheets supplied to them, that the men must have taken considerable interest in the inquiry, as well as have taken no common pains in giving the information sought.

To form any conclusions on insufficient premisses is a rank offence in science, and it would be absurd to suppose that this single report throws any light on the mysteries of migration. But we are greatly mistaken if

[1] We give all credit to these gentlemen for the originality of action, but the conception of some such scheme had been taken up before. Among the numerous inquiries in which Mr. J. H. Gurney, jun., had engaged himself, he had already made some endeavours in this direction, and we are in a position to say that even prior to his time, though nothing came of it, the idea had been broached informally among some zoological members of the British Association for the Advancement of Science. Of this fact we, however, believe that Messrs. Brown and Cordeaux were not conscious, as indeed it could hardly happen that they should be.

some of them may not be cleared up by a series of such reports, and the chief value of the present successful attempt is, in our humble opinion, to show that the plan put into operation by Messrs. Cordeaux and Brown is workable, and we sincerely trust that they will continue their enterprising efforts. The amount of correspondence and trouble it must give them cannot fail to be very great, but they, as well as the lighthouse and lightship keepers, will have one kind of reward, and that, perhaps, one not altogether unsatisfactory. They will obtain the true gratitude of all ornithologists who believe in ornithology as a study of life, and we believe will receive from ornithologists without exception the credit and encouragement they so richly deserve. If the scheme can be kept going for half-a-dozen years we can scarcely fail to be in a position to know something worth knowing of the

> . . . . "wild birds that change
> Their season in the night, and wail their way
> From cloud to cloud," . . . .

whose movements at present give rise to so much speculation, and thereby, perhaps, penetrate another, and certainly one of the most interesting of nature's secrets.

THE RIVER OF GOLDEN SAND

The River of Golden Sand. By Capt. William Gill, R.E. With an Introductory Essay by Col. Henry Yule, C.B., R.E. (London: John Murray, Albemarle Street, 1880.)

"THE River of Golden Sand," the narrative of a journey through China and Eastern Tibet to Burmah, is likely to prove one of the most valuable books of travel that have been published for a considerable time. It is prefaced by a long and able introductory essay by Col. Yule. In it are indicated many points of geographical interest in the country in which the River of Golden Sand is taken as the axis—the part of Eastern Tibet which intervenes between India and China—and the history sketched of explorations in this extent of country previous to Capt. Gill's. This essay is so full of interest and information that we shall try to give a summary of the facts detailed in it.

The first thing that strikes an observant eye in looking at a map of Asia is the number of great rivers that rush southward in parallel courses within a very narrow space of longitude. This forms the most striking characteristic of the country between India and China. The first of these rivers, beginning at the west, is the Subanshiri, coming from the Himalaya and entering the valley of Assam. The next is the Dihong, which joins the Lohit—Brahmaputra proper—at Sadiya. The third river is the Dibong, which joins the Dihong before its union with the Brahmaputra. It is now believed that this does not come from Tibet. The people of Upper Tibet say they have only two rivers coming from Tibet—the Dihong and the Brahmaputra. The Brahmaputra enters Assam at the Pool of Brahma. This, from a curious piece of evidence given by Col. Yule, is evidently identical with Kenpu of Chinese geographers. The Ku-ts-Kiang is almost certainly a source of the Irawadi. The remotest sources of this river do not lie further north than 30° at the utmost. Its length is considerably shorter than the River of Golden Sand. The Mekong has its source in the far north of Tibet. Its lower course has only been known accurately since the French expedition. But the town of Tsiamdo, standing between its two main branches about latitude 30° 45′, was visited by missionaries in 1866, so that its course is known as far north as this.

The Chin-Sha, from which Capt. Gill's book takes its name, is, if not the greatest river in Asia, the longest. Capt. Gill followed the windings of this river, with a few digressions, during twenty-four marches on his way from Bat'ang to Ta-li-fu. This great river has its source in about 90° longitude—almost as far west as Calcutta. At this part of its course its channel is 750 feet wide, and the whole river from bank to bank nearly a mile wide. Flowing into China, it receives the name of Kin-Sha-Kiang, which it retains until joined by the Min, coming from Ssu-ch'uan. There it becomes navigable to the sea. The navigation has often many hindrances in the way of rapids and gorges. Capt. Gill was the first to give us any accurate knowledge of the Yun-nan and Tibetan part of this great river.

The remaining two parallel rivers are the Ya-lung-Kiang and the Min-Kiang. Capt. Gill is the only traveller that has traced the latter river to the alpine highlands.

How to obtain direct communication between India and China has always been a difficult problem. India first became known to China not across the mountains and through the river valleys, but by the enormous circuit of Bactria and Kabul. In the year 127 B.C., Chang-Rien, a military leader, in exploring the country round the Oxus, brought back a report of a land called Shin-tu, *i.e.* Hindu, India. Attempts were made several times to penetrate by the Ssŭ-ch'uan frontier to India, but with little success. Two hundred years later, when communication opened with India, it was by way of Bactria, and went on so for centuries. In the "Periplus," a work of the first century A.D., mention is made of trade in silk stuffs through Bactria to Bhrōch. Marco Polo, when making his way to the frontier of Burma, went by the same route as Capt. Gill on his ninth march from Ch-eng-tu. Ta-li-fu, which is so often spoken of in Capt. Gill's book, is a central point on the Chinese frontier. For centuries it has been the centre of all military and commercial communication between China and Burmah.

By the treaty of Tien-tsing British subjects received the right to travel in the interior of China. Modern exploration dates from this, and our knowledge of the physical geography, natural resources of the country, and characteristics of the people of China have been slowly growing. It must not be forgotten that the missionaries of the Roman Church travelled much over China and Tibet. Publicity would have been against their purpose, and geographical research was not their object, so that their journals came before a limited few. Abbé Huc, in his famous story of his journey with Gabet, gave the first picture of Eastern Tibet in modern times in 1850. Carl Ritter's great work, which appeared many years before Huc's, gives a great deal of information of the great road by Ch'eng-tu to Lhassa. Apart from the little known efforts of the Roman Catholic missionaries, no attempt was made to penetrate those regions until 1861. Blakiston's exploration of the Upper Yang-tzu, after the treaty of Tien-tsing, was the first in this direction. In 1867 the great French expedition to Ta-li under Garnier was made. This was the first time that any European traveller (not a priest) had seen the Yachi of Marco Polo since he himself was there in 1283. In 1860 Mr. Cooper traversed from Han-kow to Bat'ang over the high plateau, the scene of Capt. Gill's expedition afterwards. Cooper hoped to reach India by China, but on the Chinese frontier his party had to stop their journey owing to the disturbed state of the country. There was not much geographical information collected on this journey. In 1872, Baron Richthofen at Ch-eng-tu was on one of those important journeys which forms the groundwork of Capt. Gill's work. His project came to an untimely end. In speaking incidentally of the labours of the Roman Catholic missionaries, Abbé Desgodins must not be forgotten.

In 1873 Augustus Margary was appointed to explore the country between the Irawadi and China. He successfully reached Bhamo from China, but on his return journey he met his tragic end. Since that time there has been a more recent journey made by Mr. Baber by a new route to Ta-chien-lu.

Capt. Gill's first journey was through the north of Pe-chih-li to the sea terminus of the Great Wall. His ascent of the Yang-tzŭ is full of interest. The greatest importance attaches to his journeys when he commenced his excursion from Ching-tu to the Northern Alps, to where the Chinese Kiang flows southwards into Ssŭ-ch'-uan. It was at this time that Capt. Gill came among highland tribes called Man-tzu and Si-fau. The people along the westward frontier are named by the Chinese Lolo, Man-tzŭ, Si-fu, and Tibetan. The Chinese look upon the Man-tzu as descendants of the old inhabitants of Ssŭ-ch'uan. Man-tzu and Si-fau are ambiguously used. Si-fau is used in Capt. Gill's book as applied to a Tibetan-speaking race in the north-east of Tibet.

Capt. Gill had meant to make a journey through Kan-suh to Kashgaria, and from that through the Russian dominions to Europe. This plan was rendered impracticable by the unsettled state of affairs between England and Russia. His homeward route was the same that Cooper had tried nine years before by Lit'ang, Bat'ang, and Ta-li. He left Ch'eng for England by the Irrawadi on July 10, 1877. The first important place reached was Ya-chau. It is here that the trade of Tibet begins, brick tea or cake tea being the staple of the trade. Capt. Gill gives interesting details about this, and also of a similar manufacture at Hankow for Mangolia. English rupees have become the currency in Tibet. They have superseded the tea bricks which were formerly used as money. The great drawback to the tea trade in Western Tibet does not lie in the Chinese being unwilling to open the landward frontier, but in the jealousy of the Lamas. Their chief desire is to monopolise power, enlightenment, and trade.

Capt. Gill's second place of landing was Ch-eng-tu, the Chinese gate of Tibet, on the Ssŭ-ch'uan frontier. Very little is known of the ethnography of the tribes on the mountain frontier of China, Burma, and Tibet. The two most prominent are the Mossos and the Lisus. They have some claims to civilisation. The men are quite Chinese in appearance, and have adopted the dress and the pigtail. The women retain a fashion analogous to the fashions of the Swiss and Pyrenean valleys. Their vocabularies have 70 per cent. words common to both, and show a connection with some of the Burmese.

Capt. Gill has given a remarkable manuscript to the British Museum. Its hieroglyphical characters are unknown. It consists of eighteen pages about 9½ inches by 3½, each page having three lines, and the characters reading from right to left. The groups of characters are divided by vertical lines. Some of them resemble the old Chinese characters called Chuen-tzu. M. Terrier has in his possession another manuscript resembling this one, but probably Capt. Gill's one is much older. Garnier, while in Hu-nan, was told that in some caves near that province were found chests containing books written in European characters. Probably they may have been books belonging to extinct aborigines in phonetic characters.

The introductory essay, written by so high an authority as Col. Yule, will greatly enhance the value of Capt. Gill's work.

The work is in the form of a journal, and is so graphically written that throughout the interest never flags. The account of the journey through the north of China is full of information regarding the physical aspect of the country and the many beautiful scenes Capt. Gill passed through. Pekin, it appears, is much the same as in the time of Marco Polo, but a great deal of its former grandeur seems to have gone. That 300,000,000 of people should have remained unchanged for centuries seems a very extraordinary fact. Yet in whatever part of the world the Chinese are found they still retain the individuality of their race, and act in all things as their forefathers did hundreds of years before. Their lack of imagination and love of independence, Capt. Gill thinks, account greatly for their stagnation. If the Chinese ever had any originality, perhaps the worship of antiquity and the system of examination have had something to do with eradicating it.

The voyage along the Chin-Sha-Chiang was full of surprises; the scenery was constantly changing. At one time the river went winding through "great plains where broad lagoons lay stretching out amongst fields that were protected from the summer floods by extensive dykes and embankments." Now the grand river, clear and almost green, rolled below cliffs of red sandstone. Beyond Ch'ang "the river narrows from 400 to 500 yards. Steep spurs from the mountains 3,000 feet high run down to the water's edge, their sides, wherever not absolutely perpendicular, covered with long, orange, brown grass, that seems to grow almost without soil. On the more gentle slopes terrace cultivation is carried on. Little patches of the most brilliant green, sometimes a thousand feet above the river, show the presence of some industrious farmer who will not leave a square yard uncultivated if he can help it." "The Chinese," Capt. Gill says, after speaking of their great industry, "plough about as well as the natives of India, doing little more than scratch the ground. It is true they raise two crops on the same field, as, for instance, when they plant opium under rape, or yams under millet. They have no knowledge of the modes of improvement practised in the various breeds of cattle; no instruments for breaking up and preparing waste land; no system for draining and reclaiming swamps and morasses." On the banks of this river Capt. Gill saw flowers being picked from a tree like an apricot-tree. The blossoms were like long conical-shaped pods; on their surface were numerous small flowers full of pollen. The poor people make a drink from these instead of tea. This flower could not be identified, although high botanical authorities were consulted.

The Chinese could not understand why any one should travel in discomfort when he could stop at home in ease. They cherish the most profound respect for any literary person, so to explain his incomprehensible habit of looking at everything, Capt. Gill went about with a note-book in his hand, telling them he was going to write a book. He came on many villages whose original inhabitants had been expelled by the Chinese, who still continue their advance, stopping only where the soil and the climate refuse fruits to those industrious agriculturists. Ch'eng-tu, where Capt. Gill made some considerable halt, has changed much since Marco Polo wrote his description of it. The same river still runs by the city, but not through it, as it did then. The large plain that incloses the town has gradually been drained. At one time it must have been the bottom of a lake. Many insect-trees were met with on the way to Tibet. "It is on this tree that the insect is bred that produces the white wax of Ssŭ-Ch'uan. The trees are something like willows. Here the insect emerges from his egg, and the branch of the tree on which he is placed is soon covered with a kind of white wax secreted. It is this white wax that is so celebrated, and is one of the most valuable products of Ssŭ-Ch'uan. These eggs cannot be exposed to the heat of the sun, and whilst being carried from the breeding to the producing district the coolies travel only in the night, when the road is said to present a very remarkable appearance, as they all carry lanterns. Ordinarily in China no travelling is done at night, and as the gates of all towns and cities are closed at dusk, and are never opened for anybody, no matter who he may be, travelling at night is rendered impossible. But during the time for bringing the eggs to Kia-Ting-Fu all the city gates are open night and day—probably the only exception in China to the rule of shutting the gates at dusk. The one day it seemed to Capt. Gill as if "the happy valley of Rasselas had been in Tibet," the next day he was driving through piercing cold. On his way to Batang he had a glorious view of Mount Neu-Da. "No words can describe the majestic grandeur of that mighty peak, whose giant mass of eternal snow and ice raises its glorious head seven thousand feet above the wondering traveller, who yet stands within five miles of its summit. He can but gaze with admiration and appreciate the feelings of the Tibetans that have led them to call it Neu-Da, or the Sacred Mountain."

The Lamas seem to be the great curse of Tibet. The scapegrace of a family goes into a Lamassery, not, however, entirely for devotion, coming home at short intervals for amusement. "The Lamas assist in no way in the maintenance of the State; their lands are free from taxation, and they do not pay one iota towards the Government expenses." The customs of the people of Tibet seem to resemble those of the Israelites. They pray on the house-tops, pay their cattle-keepers as Jacob did, and set before strangers "butter in a lordly dish." The population is diminishing in Tibet by the oppression of the Lamas and emigration to Yun-Nan. The land that the emigrants leave behind them goes to the Lamasseries. As it cannot be taxed the burden of taxation becomes heavier on the remaining people, who still have to make up the same amount.

At Shin-Ku Capt. Gill bade adieu to the River of Golden Sand and continued his route to Bhamo, in the footsteps of Marco Polo and Augustus Margary. He came on the scene of Margary's death. The most fitting tribute that could be paid to this brave officer was "to establish in those border-lands the right of Englishmen to travel unmolested."

Instead of a gigantic river like the Chin-Kiang, the Irawady above Bhamo, though wide, is very shallow. The continual rain that falls over its basin is very great. At Bhamo Capt. Gill was welcomed by Mr. Cooper, who in all his dangerous wanderings had escaped with his life; when safety seemed to come he fell by the hand of an assassin under the British flag. Capt. Gill's homeward journey was through New Mandalay.

Capt. Gill's book will prove a valuable authority on the particular part of China through which he travelled. It does not represent the scientific results, which were published in the *Journal* of the Royal Geographical Society. His journey in Western China is one of the most successful that has been made, although it was achieved under a great drawback; he did not know the Chinese language. He was, however, very fortunate in his two interpreters, but his success was due to his great tact and perseverance. He tells his story with a brightness and impressiveness not common in modern books of travel, and his originality and independence of view are evident in every page. He has no very great opinion of the Chinese, and his remarks on their peculiar characteristics are well worth consideration. One sees the born traveller in every entry in his journal; nothing is thrown in for effect. A great deal of his journey was made in the dark, through fog and rain, yet he adhered strictly to his rule of writing the accounts of the day's doings every night. This had often to be done with the comforting thought that most probably the record would be lost.

The work is well supplied with maps and illustrations, the former especially being among the most valuable of recent contributions to the hydrography of Asia.

OUR BOOK SHELF

The Geological Record for 1877. *An Account of Works on Geology, Mineralogy, and Palæontology published during the Year, with Supplements for* 1874–1876. Edited by William Whitaker, B.A., F.G.S., of the Geological Survey of England. (London: Taylor and Francis, 1880.)

WE hail with pleasure the appearance of the fourth volume of this most valuable work. The indefatigable editor deserves all praise for the energy with which he has worked in getting together a staff of volunteers to compile the useful abstracts of contents of the numerous works and memoirs noticed in this volume of 432 pages. It is unfortunate that the work has now fallen two years into arrear, but, now that the staff of contributors seems to have fairly settled down to its work, we hope the editor will soon be able to recover lost time, and that each succeeding volume will appear within the year following that for which it is issued. The editor has been very happy in discovering a method by which the officers on the staff of the Geological Survey may usefully employ their leisure, by contributing to geological literature, and we heartily wish him success in his work.

Ensayo sobre una nueva enfermedad del Olivo. Por Don Pablo Colvée. Publicado en la Gaceta Agricola del Ministerio de Fomento. Pp. 43, pl. i-ii. (Madrid, 1880.)

IT appears that the Spanish olive crop is being jeopardised in the neighbourhood of Valencia by an insect of the family *Coccidæ*, distinct from *Lecanium oleæ*, already known as attacking the olive, and considered by Don Pablo Colvée to be a new species of the genus *Aspidiotus*, which he describes as *A. oleæ*. It apparently attacks the tree generally, but especially the fruit, causing the full development of the latter to be arrested. The greater part of Don Colvée's paper is occupied by considerations on the development of insects in general, and on those attacking the olive in particular. The author appears to suggest no special remedy, but judiciously invites investigations as to whether the attacks of the insect are the primary cause of the want of health in the trees, or whether the latter does not invite the attacks.

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.*]

Winter "Swallows"

SOME months ago I tried to investigate, so far as possible, the many recorded occurrences of swallows in this country in winter. As might be expected, a large proportion of them broke down on inquiry, but there was one which, for several reasons, I thought might be safely trusted. It appeared in the "Remarks on the Weather during the Quarter ending 31st of March, 1864" (p. 5), appended to the Registrar-General's Report for that period, and stands thus:—

"*Swallows were seen* on January 22d, three miles south of Grantham."

Through the kindness of Mr. Glaisher, F.R.S., and of Mr. Jeans of Grantham, I was at last put into communication with the original circulator of the statement, who obligingly wrote to me (omitting names) as follows:—

"——— Grantham, Sept. 23d, 1879

"SIR,—The information given to ——— respecting the swallows, I discovered some time afterwards was not correct; what was taken to be swallows were the common bat. I much regret being instrumental in incorrect statements being published; it was an Irishman in my employ who told me of them; he some time afterwards showed me what he supposed to be swallows.

"I remain, sir,
"Your obedient servant,
"——— ———"

I leave to others the moral that may be drawn from the above.

ALFRED NEWTON

Magdalene College, Cambridge, May 9

Does Chlorophyll Decompose Carbonic Acid?

I HAVE read with much interest in NATURE, vol. xxi. p. 557, Prof. Lankester's remarks on the question—Does Chlorophyll decompose Carbonic Acid? and having many years ago made experiments on that and kindred topics, should be much obliged if you will do me the favour to reprint the following extract from a paper I published in the *Philosophical Magazine* (December, 1872, p. 425, &c.). This is also in my scientific memoirs, p. 409, 410.

"The decomposition of carbonic acid by plants is undoubtedly the most important of all actino-chemical facts. The existence of the vegetable world, and, indeed, it may be said, the existence of all living things, depends upon it. I first effected this decomposition on the solar spectrum, as may be found in a memoir in the *Philosophical Magazine* (September, 1843). The results ascertained by me at that time from the direct spectrum experiment, that the decomposition of carbonic acid is effected by the less, not by the more refrangible rays, have been confirmed by all recent experimenters, who differ only as regards the exact position of the maximum. In the discussions that have arisen, this decomposition has often been incorrectly referred to the *green* parts of plants. Plants which have been caused to germinate and grow to a certain stage in darkness are etiolated, yet these, when brought into the sunlight, decompose carbonic acid, and *then* turn green. The chlorophyll thus produced is the effect of the decomposition, not its cause. Facts derived from the visible absorptive action of chlorophyll do not necessarily apply to the decomposition of carbonic acid. The curve of the production of chlorophyll, the curve of the destruction of chlorophyll, the curve of the visible absorption of chlorophyll, and the curve of the decomposition of carbonic acid are not all necessarily coincident. To confound them together, as is too frequently done, is to be led to incorrect conclusions."

Nothing can act before it exists, nothing can originate itself. Chlorophyll is therefore the result, not the cause, of the decomposition. Its continual increase during the life of a plant is an effect of the same kind. The force decomposing carbonic acid does not reside in chlorophyll, but elsewhere in the structure of the leaf.

JOHN WILLIAM DRAPER

University, New York, April 28

On a Point Relating to Brain Dynamics

ANY attempt to grapple with the doctrine of Free Will *v.* Necessity on the old lines would probably (and deservedly so) not attract much attention. The object of this paper is to place a consideration of extreme simplicity under critical notice, which would seem to be capable of affording a key to the complete reconciliation of the divergent views on a common basis; and since the matter to be dealt with will be strictly within the domain of natural science, a clear analysis will be rendered possible.

It is well known that the only attempt to harmonise the doctrine of Free Will with the principle of the Conservation of Energy consists in supposing that living creatures have a power, by the mere exercise of their "will," of deflecting particles of matter within their bodies from their natural paths, without thereby altering the total energy of the particles.[1] This, therefore, it will be observed in the first instance, assumes a peculiar physical state of things to exist within the body of an animal which does not prevail elsewhere, or it supposes that the laws of nature have not a general application, but that the animal world must be made an exception. This at the very outset evidently involves a very questionable admission. My purpose is simply to point out that by taking into account a special consideration based on the evidence of modern physiology as to the functions of the brain, such an assumption as the above is rendered entirely superfluous, and that even if it could be supported it would still miss the main object in view.

Whatever room for speculation there may be as to the exact nature of the mental faculties, it is at least very generally admitted that these faculties are most intimately *connected* with or dependent on brain structure. Modern physiological research has at least placed this fact beyond question, or it is allowed that the mental faculties have at all events *a physical side*. From this it must follow therefore that what we call "identity," character, or individuality (as involved in "mind") must be dependent on the special structure of the brain; indeed this view is so widely prevalent that it becomes almost superfluous to insist upon it. Now it may be safely assumed that no upholder of Free Will would wish for more than that a person should act in strict accordance with his identity or individuality, for the object of Free Will certainly is not to annihilate individuality (or those personal *traits* which constitute character). But is not this precisely what would occur if this contention for a mysterious power of deflecting particles within the body could be carried out? for the effect of this contention would be to make the brain superfluous as a directing mechanism, which would be tantamount to abolishing it (together with the individuality, of

[1] The necessity for this special assumption, in order to prevent Free Will from coming into direct collision with the principle of the Conservation of Energy, is so obvious that it will probably be regarded as superfluous to give references to particular authors.

which it is the seat). For where would be the use of the elaborate mechanism of the brain for directing the movements of the body if we are to have power of carrying out this same object by deflecting particles by "volition" (whatever that may mean)? This would be to substitute for the brain, with which the identity is bound up, the empty nothing "volition." In that the brain directs the corporeal movements; the identity, or that which constitutes the very essence of individuality, thereby directs. What more would we have? Attempt to supplant the brain by the vague notion "volition," and the individuality ceases to exist; or that very end is attained which those who support Free Will most wish to avoid.

From the very fact that the brain is *known* to exist, it therefore should be perfectly conceivable (if not even *à priori* a natural conclusion) that the brain might be a mechanism competent to regulate all[1] the motions of the corporeal system (for a set of dynamical conditions adapted to *any* effect is conceivable). In view of this, does not the assumption of this mysterious "deflecting power" seem all the more unwarrantable, or even absurd; as if it were imagined that the brain, being already there to direct the corporeal movements, something additional were necessary to direct the brain, or as if it were supposed that [the brain being the seat of the identity] something besides the identity were required to direct the actions of the body? This would seem to be no more than a specimen of the kind of incongruities which may be expected to present themselves by any attempt to evade physical principles.

It could not, however, be said that the opposite party were entirely free from error. For there appears to have been a notable oversight on the side of those who uphold strict Causal Sequence in nature (sometimes called "Necessity") in failing to appreciate adequately the important influence (on the question of Free Will) of the fact that the brain is the seat of individuality, as above insisted on. For the omission to give due import to this fact has naturally made strict Causal Sequence to appear as a sort of grinding process, whereby man's actions are determined *independently* of his individuality; a view which is no doubt repulsive, and may have served as some excuse for the invention of the curious device of deflecting particles by the "mind" or "will." It will be observed, however, that by simply substituting the word "brain" (which includes "mind") for the word "mind" in the foregoing sentence, a deflection of particles of matter (represented by the direction of material operations by the brain) then can take place in accordance with and not in opposition to the laws of nature. For from the very fact of the brain substance forming part of the material universe it must of course influence and direct material operations in conformity with natural causes.

Could it be justly said that there is any *compulsion* in this? Can there be compulsion in being obliged to act in accordance with one's individuality or identity (determined by brain structure), since the only conceivable escape from this would be to act *in opposition* to one's identity (scarcely a desirable end)? But, it may be argued, there is still some coercion left here, because, although brain structure may be the seat of individuality or "mind," nevertheless, since our brains were originally formed by the operation of causes beyond our control, there is coercion in this aspect of the case. But then do even the most ardent supporters of Free Will ever dream of upholding the expectation that an individual should have a control in the original formation of his brain? or do they not concede (and rightly) that the ideal of Free Will is that an individual should act in strict accordance with (and not in opposition to) his own identity? Yet this is precisely what the believer in strict Causal Sequence, who has a just appreciation of the functions of the brain, will maintain must necessarily occur. Solely in virtue of the fact that there is strict Causal Sequence in nature are the actions brought into strict conformity with individual brain structures (or with identity). If the principles of dynamics were not rigid, or if the laws of nature were liable to alteration, a man's actions might sometimes be in harmony with his brain structure, sometimes in discord with it; or any number of persons, though possessing totally different brain structures, might act identically. The questionable expediency of the proceeding of those who are disposed to grumble at what they term the "iron" laws of nature, becomes apparent here.

But is it not, after all, more satisfactory to look to a definite physical basis for identity or idividuality, as dependent on the magnificent mechanism of the brain, in preference to the superficial view of ignoring all this? No doubt there have been misunderstandings on both sides of this Free Will *v.* Necessity question.—The Free Will party, failing to appreciate justly the sequence of cause and effect; the Necessitarians, on the other hand, omitting to realise fully the important bearing of the relation of individuality to brain-structure on this question. No logical ground could be given why a complete agreement should not be possible on this subject. For there can evidently be but *one* correct view on any subject or question whatever. Moreover, from the very fact of the fundamental character of this question, it would follow necessarily that the wrong view on this subject must involve a great error, which, therefore, could hardly escape detection under a careful analysis. The divergence of views here is, however, no doubt more apparent than real. For if Free Will may be justly regarded as the freedom to act in accordance with identity (or as the assertion of individuality), then such freedom of will actually exists, and moreover the very condition for its existence is seen to be the prevalence of that strict Causal Sequence in nature demanded by the Necessitarians. Thus the two views would show themselves capable of reconciliation on a common basis. That this fact should have apparently hitherto escaped appreciation may possibly be to some extent due to that spirit of partisanship which has so largely entered into this question, whereby the judgment may be allowed to be unconsciously biassed, so that in some cases, instead of searching impartially as to what *is* truth, the inquiry has perhaps rather been as to what *ought* to be truth.

London S. TOLVER PRESTON

[1] Does it not seem a violation of principle, or a kind of inconsistency, to recognise that the brain does, in fact, direct certain motions of the corporeal system (and even those of a complex character, such as the digestion of the food, the circulation, &c.), and yet to assume that the brain would be incompetent to direct *all* the motions of the body? It may be said that a reasoning process accompanies the direction of some of these motions, but not others. But then is not reasoning itself a brain process, or is it not universally admitted that the reasoning faculty (whatever its exact nature) is at least *connected with* the brain, or has a physical side, just as, indeed, the mental faculties generally (or "mind") could not exist without brain?

Curious Botanical Phenomenon

ABOUT a fortnight ago I noticed a curious phenomenon in a wood near Leyland, Lancashire. The ground was strewn with a layer of about eight to ten inches of old sodden leaves, covered at the surface by dry withered ones. A quantity of hyacinths (not yet in flower) were growing on this ground, and many of the plants had pierced through the withered leaves to the extent of from half an inch to three inches, carrying them up above the general surface. Some of the hyacinths had in this way penetrated through more than half a dozen withered leaves, and here and there several plants were gathered together at their tops by a number of old leaves, through which they had conjointly grown.

The question arises as to whether the hyacinth shoots had pierced through the withered leaves on first issuing from the ground, when the dead leaves were soft and wet, and so lifted the latter to the surface where they became dried, or whether they had actually pierced through the dry leaves on the surface.

M. F.

Carboniferous Forest at Oldham

IT may perhaps be interesting to the readers of NATURE to know that here at Oldham we have recently laid bare a fine sample of a carboniferous forest. We are here, as you are aware, situated on the middle coal-measures, Oldham Edge (800 feet) being the highest outcrop of that series.

I have been watching with increasing interest during the past eighteen months the progress of disinterment. For some time at the commencement the trees occurred at considerable intervals of time, but of late they have turned up more frequently, scarcely a day now passing without one or more being unearthed. They are, I am sorry to say, highly perishable, and if the necessities of the works did not require their removal they would all disappear during a single winter if exposed to the weather.

The result of the combined action of the two great faults that cross Oldham in a direction parallel to each other has been to throw up to the surface several seams of coal and beds of shale and sandstone.

On the eastern escarpment of the "Edge" a quarry has been dug in the argillaceous shale above what is here known as the "Bent Mine," in order to make bricks of the extracted materials. In quarrying this bed the trees have been laid bare in considerable numbers. Some of them show the characteristic markings of Sigillariæ, longitudinal flutings and the usual leaf-scars, stigmarian roots and rootlets attached, &c., others not so well preserved, being of doubtful affinities. Of course they are now but casts, nothing remaining of the original trees except a thin film of coaly matter representing the bark. They measure in height from three to ten feet, and have a diameter of from one foot to two feet four inches. I think it may be safely stated that they were merely hollow stumps when finally submerged, fronds of ferns, lepidodendroid twigs and leaves, and other vegetable waifs having found their way into the hollow cylinders and left their impress on the inclosed matrix.

I may add that there are several horizons of growth, one forest having grown above another; stigmarian roots and rootlets, calamites, lepidodendroid stems and leaves, lepidostrobi, and masses of leaves of unascertained species being indiscriminately mixed throughout the whole section, the ferns, however, being met with in greatest numbers near the bases of the erect trees.

It is perhaps worthy of remark, too, that there is no accumulation of coaly matter in the section revealed, nor is there any of the usual "floor clay" about the roots of the trees.

29, Radcliffe Street, Oldham JAS. NIELD

Fungus Inoculation for Insects

THE importance attributed by Dr. Lankester (NATURE, vol. xxi. p. 448) to "Prof. Metschnikoff's suggestion of a deliberate cultivation of an insect's-disease-producing fungus, and the application of the cultivated fungus in quantity to places infested by these insects," invites attention to the fact that the suggestion has been anticipated in a very serious and earnest way by my friend the distinguished entomologist, Dr. John L. Le Conte of Philadelphia, in his presidential address before the Portland meeting of the American Association for the Advancement of Science, in August, 1873.

His address concluded with ten suggestions for the promotion of economic entomology in the United States, and the seventh reads thus:—"Careful study of epidemic diseases of insects, especially those of a fungoid nature; and experiments on the most effective means of introducing and communicating such diseases at pleasure."

The reasons for making this suggestion are fully stated in the preceding paragraphs of the address, where the observations on which it is based are detailed.

Dr. Le Conte's first suggestion was, "Reorganisation of the Department of Agriculture [at Washington] on a scientific basis, for the proper protection and advancement of agricultural interests." Had this suggestion received the attention which has been given to many other subjects of less practical importance, the present reclamation for him of priority in the case of his seventh suggestion, would probably have been rendered unnecessary; and the credit of introducing a more reasonable method of extirpating insect-pests than the dangerous plan of distributing potent mineral poisons to careless or uneducated persons for use in the fields, would have been secured to the nation to which we have the honour to belong.

Dr. Le Conte's address may be found in the published volume of the *Proceedings* of the Portland meeting; but it was reprinted by him and extensively circulated and favourably commented upon at the time, his desire being precisely that so well expressed by Dr. Lankester "to do something to persuade 'practical' men that all science is deserving of their respect and encouragement." We all hoped that such earnest words from so high an authority would have their due effect upon Congress and inaugurate a long-desired reform of our Agricultural Bureau. But it has happened, as in so many other instances, that we have had to wait seven years before even an echo reaches us from a distant part of the world, where the labours of Prof. Metschnikoff have procured an intelligent appreciation of the value of Dr. Le Conte's suggestion, so little comprehended by the powers at home. J. P. LESLEY

1,008, Clinton Street, Philadelphia, April 10

Carnivorous Wasps

A SERIES of letters, under the above heading, have appeared in NATURE for several weeks past. The facts they contain, although interesting in themselves, are nothing new to entomologists. That wasps are carnivorous, that they chase flies, &c., was known long ago (compare Westwood's "Introd. to Entomol.," ii. p. 246). That wasps cut off the wings of flies before sucking them was observed by Dr. Erasmus Darwin in the last century (see J. H. Fabre, "Souvenirs Entomologiques," Paris, 1879). AN OLD ENTOMOLOGIST

Heidelberg, Germany, May 6

Seeing by Telegraphy

WE beg to thank Mr. Gordon for drawing attention to the fact that the principle of rotation of plane of polarisation of light in a magnetic field could not actually be employed with the form of receiver symbolically described by us in NATURE, vol. xxi. p. 589. Having satisfied ourselves that there could be no doubt of the feasibility of using the first form of apparatus, which we spoke of, as a receiver in a sight telegraph, we merely wished to point out, at the end of our letter, that other methods might perhaps be employed; and we still have no doubt that with a certain proper arrangement of the apparatus not only the effects observed by Dr. Kerr, but other of the Faraday polarisation of light effects might be practically made use of. For it must be remembered that the actual electric currents now used to transmit articulate speech are only one forty-millionth per cent. as strong as those necessary to work even a delicate telegraph relay, whereas it required several Grove's cells to show in a decided way the old experiment of the sound emitted by an iron bar on being magnetised.

And in fact we may go further, and mention that we have for the last year, or more, held the view that just as all electric conductors turn into heat energy a portion of the energy they transmit as electric current, so there must be some bodies, presumably of the sulphur selenium order, which, when properly employed, will convert a portion of the current energy into visible luminous vibrations, and may therefore be used as receivers in a sight telegraph.

As to the other objection that might have been made to the method as popularly described by us in consequence of the large number of wires, we need hardly mention that in practice a telegraph engineer would avail himself of the principles of multiple telegraphy. JOHN PERRY

May 3 W. E. AYRTON

Anchor-Ice

IN confirmation of Mr. Rae's views upon this subject, the following results of observations made upon the Charles River, Mass., may be of interest.

Anchor-ice is usually formed at night during a sudden "cold snap," when the river is not covered with surface-ice. It seems to consist of small masses of needle-like crystals grouped in stellate forms, and distributed pretty evenly throughout the body of water.

These adhere readily to any obstruction, and accumulate rapidly upon it. Thus the racks or strainers through which the water passes to the mills are covered and closed by it, so that the flow of the water is absolutely stopped, and the mills can only be kept running by constantly removing it with a rake.

It is very adhesive and tenacious. I have frequently seen it accumulate upon portions of the extreme edge of a mill dam (over which was pouring water a foot in depth) until it reached the surface, resisting for a considerable time the enormous pressure to which it was thus subjected. It usually disappears soon after sunrise.

Detached portions of the accumulated masses always rise to the surface, but the original crystals, if not heavier than water, seem to be at least as heavy. The general appearance of this ice when removed from the water resembles that of sherbet or "water ices." As these are frozen quickly while in motion, they are apparently formed under similar conditions. I have never seen anchor-ice except in rapid currents.

Boston, U.S.A., April 24 C. F. C.

SODIC CHLORIDE CRYSTALS.—Dr. Ord refers Dr. Ralton to Dr. Beale's book on "Kidney Diseases, Urinary Deposits, &c.," ed. 1869, p. 167, and the figure at p. 130; also Thudichum's "Pathology of the Urine."

OXONIENSIS.—Apply to the Secretary, British Association, Albemarle Street, W.

FURTHER OBSERVATIONS AND RESEARCHES ON FLEUSS'S SYSTEM OF DIVING AND LIVING IN IRRESPIRABLE ATMOSPHERES[1]

YOU will find in NATURE, vol. xxi. p. 62, the experiments I made in relation to the process of living under water by means of the Fleuss apparatus. I there related what I had observed after Mr. Fleuss had been under water at a very low temperature for the period of an hour. A few days later I made another observation on a different plan. I filled the large diving bell at the Polytechnic with carbonic acid gas, displacing every portion of air. I then let the bell go down ten inches under the water, so as to put the gas under pressure, and all the while I kept a stream of gas pouring into the bell, and causing a constant bubbling of gas out of the mouth of it into the water. This done, Mr. Fleuss put on his dress and helmet and entered the bell. He sat in it over the water for the period of twenty minutes, the pressure and constant stream of gas being maintained. At the end of twenty minutes I signalled to him to come out, and had the bell brought round to the side of the tank. He returned into the air quite unaffected. His pulse, which was beating at 72° in the minute when he went in, was at 68° when he came out, and quite steady. His temperature in the mouth, which was at 98·2° F. when he went in, was at 97·5° when he came out, and in a few minutes was at its natural standard. He said he had felt no oppression whatever, and would have remained an hour in the gas if I had allowed him.

While the diving-bell was still charged with a large volume of carbonic acid gas I got Mr. Fleuss to go into it again, and then volatised into the bell vapour of amyl hydride until I had made an utterly irrespirable atmosphere from that vapour alone. In this way I formed an atmosphere which closely resembled the atmosphere of the mine charged with choke-damp, except that the vapour I used is more determinate in its narcotising action than choke-damp. In this mixed atmosphere, in which a man unprotected would have been absolutely unconscious in less than a minute, Mr. Fleuss remained for twenty minutes. At that time he came out of the bell in the most perfect condition, in a word, altogether unaffected.

The principle of the Fleuss system is very simple. Within the helmet, which is of the usual shape of a diver's helmet, there is a space equal to a quarter of a cubic foot inclosed in metal. This space is charged with oxygen under pressure, the compression giving a supply of the gas sufficient to last for a period of five hours if necessary. As a rule Mr. Fleuss charges for three hours under a pressure of about eight atmospheres. This is his supply of vital air. In the cuirass, which is the next part of the apparatus to be described, he has two metal cases, one in front, the other at the back. These cases are filled with small pellets of porous india-rubber charged with caustic soda. Over this surface of soda he can exhale his breath with perfect freedom, and at the lower part of each case he has a small trough under a perforated bottom, in which the water of the breath, condensed in passing, is caught. Lastly, he has a double-valved mouthpiece, made almost exactly after the plan of the late Dr. Sibson's chloroform mouthpiece, to which is attached a large elastic artificial trachea, or windpipe.

These are the effective parts of the apparatus. The other parts, common to the diver's dress, are the waterproof jacket and leggings and weighted boots.

In preparing for his work Mr. Fleuss proceeds as you will see (for he will go step by step through the process of assuming his dress). He first charges his helmet with oxygen. He does this from one of Orchard's compressed oxygen bottles, measuring the pressure by a pressure-gauge. This ready, he puts on the cuirass and the waterproof dress. Then he ties firmly over his mouth and nostrils the double-valved mouthpiece, and connects the free end of the artificial windpipe with a tube leading into the soda-chamber in front of the cuirass. Finally he assumes the helmet, and when that is on and closed he is complete.

The mode in which he lives in this closed dress is as follows:—By a valvular opening he lets into the helmet from the compressed store of oxygen a stream of oxygen, which diffuses into the space between the helmet and cuirass and his body—his breathing- or air-space. When he inhales through the mouthpiece he draws in the oxygen through the two side valves into his lungs. When he exhales, those valves close, and so his exhaled breath passes through the tube and over the soda in the soda-chambers, and down the chamber in front along a connecting tube into the lower part of the chamber at the back; then, ascending through that chamber, it escapes *in part* into the helmet by a tube from the back chamber near the shoulder. In its passage through these two chambers all the carbonic acid of the breath is fixed by the soda, and most of the water is condensed in the troughs. The return oxygen and the nitrogen of the expired breath passes over free and enters the helmet, where it meets and admixes, by diffusion, with the oxygen which is admitted from the oxygen reservoir.

Thus there is constantly being made within the dress a fresh supply of air for respiration, while the product of respiration and of animal combustion—carbonic acid—which would be dangerous if it were not removed, is removed and fixed by the soda.

Mr. Fleuss relies on two practical indications for supply of the oxygen from the reservoir. If he feels any undue pressure on the drums of his ears he knows that there is too much oxygen in the helmet. If he feels any sense of suffocation he knows that the oxygen is deficient. In the first instance he stops the entrance of oxygen for a short time; in the second case he lets in a further supply.

It must be admitted that this plan is not one that ensures a due admixture of oxygen and of nitrogen according to the atmospheric formula, and there can be no doubt that he is always breathing, while in his dress, an excess of oxygen. This fact opens up the question once more of pure oxygen as a supporter of natural life.

In my experiments on this subject reported to the British Association for the Advancement of Science in 1860, I showed that oxygen supplied in steady current from a fresh source, and not breathed many times over again, would support life readily enough for long periods of time—extending in one experiment to three weeks—at a medium temperature; but that at a low temperature, 35° F., it became negative, so that animals went to sleep in it and became cold; while at a high temperature, 75°, they became heated in it, underwent rapid wasting, and ate voraciously.

In another paper, published in 1869, I tried to prove that the use of nitrogen in the atmosphere is not to act as a mere diluent and economiser, but as an equaliser of the temperature, and so to make the combination of oxygen with the blood and the tissues equable in the different regions of the globe.

Mr. Fleuss's experiments are in entire accord with these views. He can live, with oxygen in excess, for long periods in medium temperatures. In a cold temperature his own heat goes down several degrees below the standard. In a high temperature he would become overheated. But between a range of 35° F. on the one side and 75° F. on the other he is, in my opinion, safe in his closed oxygenated chamber. Whether he can descend to the same depths as other divers—say to 86 feet—and remain there, has to be proved. Theoretically, he ought to be able to do so, but in this field of inquiry he must

[1] Abstracted from lecture delivered to the Society of Arts on Thursday, May 8.

win his spurs. The lowest depth to which he has descended is 25 feet. He has walked under water a distance of four hundred yards in a straight line.

Some improvements may be made in the arrangements. He might be supplied with a feeding-apparatus, and so remain under water several hours longer than he has done. At present he finds from two to three hours no difficulty.

The experiments I have made with the apparatus indicate that the dress and apparatus may be used for entering wells, burning houses, and mines that are charged with suffocating gases. In the mine the dress would be invaluable, and if a telephonic connection could be set up between the man in the dress and the outside world—an adaptation I believe to be quite possible—a remarkably useful advance would be made.

I will now ask Mr. Fleuss to make one experiment which will be a visible exposition of the perfection of his apparatus as he stands equipped in it. The directors of the Royal Institution have been so good as to lend me the glass chamber in which Prof. Tyndall experimented when he was demonstrating the mask he invented for breathing in an atmosphere charged with dense fumes of smoke. This chamber I have had charged with carbonic acid, so that it has in it an irrespirable atmosphere. In it, as you will see, a candle cannot be lighted, and a taper will be extinguished. Mr. Fleuss will go into the chamber, sit down in it, and wait there until the current of carbonic acid which is being admitted forms an absolute atmosphere of the gas to above the level of the top of his helmet, and there he will remain, if we like, until the supply of oxygen in the helmet is exhausted.

The next step onward will be to construct a small closed canoe, in which the apparatus can be fitted on a larger scale, and in which men, or those who are in the canoe, can rise or sink in the water and be propelled under the water. This is a certain extension of the system now under our consideration, and when it is completed, my idea that the next greatest geographical discoveries will be made on the floors of the great oceans may not be so far wide of the mark as was once supposed.

B. W. RICHARDSON

THE AURORA BOREALIS[1]

OUR experiments on the electric discharge, which have been already published in the *Phil. Trans.* and the *Proceedings* of the Royal Society, enable us to state with some degree of probability the height of the aurora borealis when its display is of maximum brilliancy, and also the height at which this phenomenon could not occur on account of the great tenuity of the atmosphere.

In Part III. of our electric researches, *Phil. Trans.*, Part I. vol. 171, we have shown that the least resistance to the discharge in hydrogen is at a pressure of 0·642 millim., 845 M; after this degree of exhaustion has been reached a further reduction of pressure rapidly increases the resistance. When the exhaustion has reached 0·002 millim., 3 M, the discharge only just passes with a potential of 11,000 chloride of silver cells (11,330 volts); at the highest exhaust we have been able to obtain (and which we believe has not been surpassed), namely, 0·000055 millim., 0·066 M, not only did 11,000 cells fail to produce a discharge, but even a 1-inch spark from an induction-coil could not do so.

Although we have not experimentally determined the pressure of least resistance for air, we have ascertained that while the discharge occurs in hydrogen at atmospheric pressure between disks 0·22 inch distant, they require to be approached to 0·13 inch to allow the discharge to take place in air. We may therefore assume that the pressure of least resistance for air is

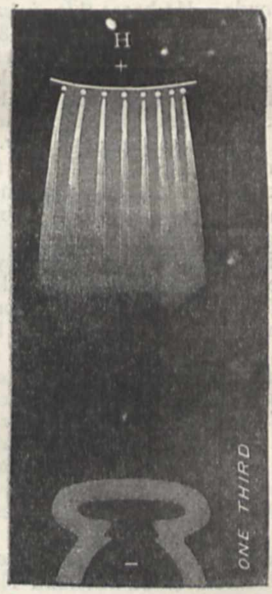
$$\frac{0·642 \times 13}{22} = 0·379 \text{ millim., } 498·6 \text{ M.}$$

At a height of 37·67 miles above the sea level, the atmosphere would have this pressure (neglecting change of temperature), and therefore the display at this elevation would be of maximum brilliancy and would be visible at a distance of 585 miles.

The greatest exhaust that we have produced, 0·000055 millim., 0·066 M, corresponds to a height of 81·47 miles, and as 11,000 cells failed to produce a discharge in hydrogen at this low pressure, it may be assumed that at this height the discharge would be considerably less brilliant, especially in air, than that at 37·67 miles, the height of maximum brilliancy.

At a height of 124·15 miles the pressure would be only 0·00000001 millim., 0·00001 M, and it is scarcely probable that an electric discharge would occur with any potential conceivable at such a height.

The colour of the discharge varies greatly with the tenuity of air or other gas with the same potential. Thus in air at a pressure of 62 millim., 81579 M, the discharge has the carmine tint which is so frequently observed in the display of the aurora; this corresponds to an altitude 12·4 miles, and would be visible at a distance 336 miles. At a pressure of 1·5 millims., 1974 M, corresponding to a height of 30·86 miles, the discharge becomes salmon-coloured, having completely lost the carmine tint. At a pressure of 0·8 millim., corresponding to 33·96 miles, the tint of the discharge is of a paler salmon colour, and as the exhaust is carried further it becomes a pale milky white. The roseate and salmon-coloured tints are always in the vicinity of the positive source of the electric current, the positive luminosity fades away gradually, and frequently becomes almost invisible at some distance from its source; as, for instance, in the hydrogen discharge at a pressure of 2·3 millims., 3027 M, shown in the accompanying figure, H, which resembles in some



respects the phenomena of the aurora. The discharge at the negative terminal in air is always of a violet hue, and this tint in the aurora indicates a proximity to the negative source.

The following table, [with] the exception of pressure

[1] "On the Height of the Aurora Borealis." Paper read at the Royal Society. By Warren De La Rue, M.A., D.C.L., F.R.S., and Hugo W. Müller, Ph.D., F.R.S.

0·00000001 millim., exhibits deductions from actual observations:—

Pressure mm.	Pressure M.	Height miles.	Visible at miles.	Remarks.
0·00000001	0·00001	124·15	1061	No discharge could occur.
0·000055	0·066	81·47	860	Pale and faint.
0·379	499·0	37·67	585	Maximum brilliancy.
0·800	1053·0	33·96	555	Pale salmon.
1·000	1316·0	32·87	546	Salmon coloured.
1·500	1974·0	30·86	529	,, ,,
3·000	3947·0	27·42	499	Carmine.
20·660	27184·0	17·86	403	,,
62·000	81579·0	12·42	336	,,
118·700	156184·0	11·58	324	Full red.

It is conceivable that the aurora may occur at times at an altitude of a few thousand feet.

The following letter has been sent us in reference to the above paper:—

Meteorological Office, 116, *Victoria Street*, *London, S.W.*, *May* 1, 1880

With reference to a paper at the Royal Society on the height of auroras by Dr. De la Rue and Dr. Müller, the following remarks in Müller's "Lehrbuch der kosmischen Physik," 2nd Edition, 1865, p. 558, may be of interest to your readers:—

"Hansteen finds for the aurora of January 7, 1831, a height of 26 geographical miles, by combining the height of the arch at Berlin and Christiansand in Norway, while Christie calculates the height of the same aurora at between 5 and 25 English miles, from observations made in England.

"The determinations of modern physicists place the aurora at a much lower level than was formerly assumed. Mairan gave the mean height at 120, Cavendish (1790) at 60, and Dalton (1828) at only 18 geographical miles.

"Farquharson makes it probable that the auroras, as was already said by Baron v. Wrangell, come down to the region of the clouds. He bases this, *inter alia*, upon the auroral observations of December 20, 1829. At Alford, in Aberdeenshire, he saw, from 8.30 to 11 o'clock in the evening, a very brilliant aurora over a thick mass of clouds which covered the hills lying to the north of his house. Although the sky was clear the aurora never rose higher than 20°. At the same time the Rev. Mr. Paull, at Tullynessle, lying two English miles north of Alford, in a narrow side valley of the hills above mentioned, saw a very brilliant aurora close to the zenith about 9.15. This would give the height of the aurora as not more than 4,000 feet. This opinion is confirmed by numerous observations made in the Polar regions by Parry, Franklin, Hood, and Richardson. Franklin observed auroras between the clouds and the earth, which lit up the lower surface of thick clouds.

"So much is certain, the phenomenon appears in various heights, but can hardly be seen higher than twenty miles. The auroras formed at low heights, which are often seen in the Polar regions, are only visible at short distances. Hood quotes an aurora on April 2, 1820, at Cumberland House, as a brilliant arch of 10° altitude. Fifty-five English miles to the south-west nothing was visible.

"Another aurora on April 6, which remained in the zenith for some hours over Cumberland House, appeared at the distance of 100 English miles to the south-west as a steady arch only 9° in height."

The observation of Mr. Smith of Jordan Hill, at Loch Scavaig in Skye, of an aurora apparently emanating from a mountain there, will also be remembered.

ROBERT H. SCOTT

A SCOTTISH CRANNOG[1]

II.—*Objects of Bone*

UPWARDS of twenty implements made of bone have been added to the general collection, all of which were found either in the relic bed or refuse heap. The following are the most interesting.

1. Two chisels or spatulæ. One is made of a split portion of a shank bone, and measures 5¼ inches long

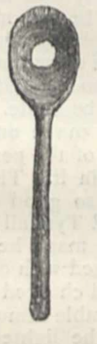


FIG. 6.—Bone (Scale ½.)

FIG. 7.—Bone (Scale ½).

and rather less than ½ inch broad. It is very hard, flat, and smoothly ground at one end, and has a sharp rounded edge, which extends farther on the left side, thus indicating that it was adapted for being used by the right hand. The other is a small leg bone obliquely cut so as to present a smooth polished surface. Its length is 4 inches, and its diameter ½ inch.

2. Five small objects presenting cut and polished surfaces, three of which are sharp and pointed; one

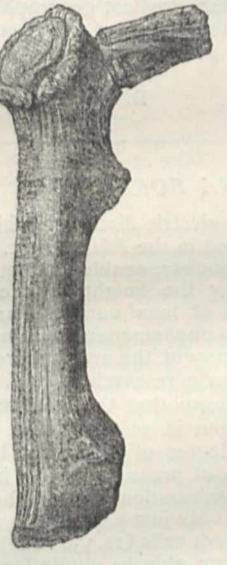


FIG. 8.—Horn (Scale ⅓).

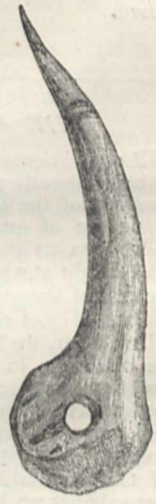


FIG. 9.—Horn (Scale ⅓).

appears to have been notched at the end and there broken off; and the last, presenting well-cut facets, is fashioned into a neat little wedge.

3. Fig. 6 represents a tiny little spoon only ¾ inch in diameter, and worn into a hole in its centre. The handle portion is round and straight, and proportionately small,

[1] A full report of the Lochlee Crannog is given in vol. xiii. of the *Proceedings* of the Society of Antiquaries of Scotland, and in vol. ii. of the Collections of the Ayrshire and Wigtownshire Archæological Association. Continued from p. 16.

being only 2 inches long, and about the thickness of a crow-quill.

4. Fig. 7 is a drawing of a neatly-formed needle-like instrument. It is flat on both sides, finely polished, and tapering into points at its extremities.

5. Two curious implements smoothly polished and forked at one end. They are both about 5½ inches long, and precisely similar to each other in every respect.

6. A great many small ribs, about 6 or 7 inches in length, and portions of others, were found to have the marks of a sharp cutting instrument by which they were pointed and smoothed along their edges. The use of these implements can only be conjectured.

7. Lastly, there are several portions of round bones which appeared to have been used as handles for knives or such like instruments.

III.—*Objects of Horn*

About forty portions of horn, chiefly of the red-deer, bearing evidence of human workmanship were collected during the excavations. They consist of hammers or clubs, pointed tynes, spear-heads, &c. As illustrations of these implements, Figs. 8 and 9 are good representations of a club and a bodkin. The former is 11 inches long, and has about 3 inches of the brow branch of the horn projecting from it, round the root of which there is a groove, as if intended for a string. The markings on the back portion indicate very distinctly that it was used for hammering some hard substance; the latter is 8 inches long, finely polished all over, and pointed at the tip as if with a sharp knife.

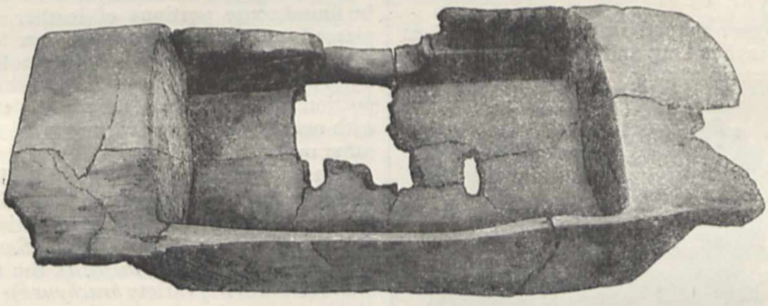


Fig. 10.—Wooden Vessel (Scale ⅛).

IV.—*Objects of Wood*

A large assortment of wooden implements was found, chiefly in the refuse heap, and in the portion of *débris* corresponding to the area of the log pavement. Owing to the softness of the wood and the large amount of moisture contained in its fibres, most of these relics have already shrunk to less than half their original bulk, and become so changed, though they were kept in a solution of alum for several weeks, that I am doubtful of being able to preserve them at all. They consist of bowls, plates, ladles, a mallet, a hoe, clubs, pins, &c., together with many objects entirely new to me, but which apparently had been used for culinary or agricultural purposes.

Fig. 10 represents a trough cut out of a single block of wood. It was found about half way between the margin of the crannog and the circle of stakes surrounding the log pavement at a depth of 5 feet, amongst decayed brushwood and chips of wood.

Canoes.—During the progress of the drainage a canoe, hollowed out of a single oak trunk, was found about 100 yards north of the crannog. Its depth in the moss was well ascertained, owing to the fact that, though lying at the bottom of one of the original drains, it presented no obstruction to the flow of water, and consequently was then undisturbed. During the recent drainage all the drains were made a foot deeper, and hence its discovery. It measures 10 feet long, 2 feet 6 inches broad (inside), and 1 foot 9 inches deep. The bottom is flat, 4 inches thick, and contains nine holes, arranged in two rows and about 15 inches apart, with the odd one at the prow. These holes are perfectly round and exactly 1 inch in diameter, and when the canoe was disinterred they were quite invisible, being all tightly plugged.

When the original drainage was made, some forty years ago, I understand that two canoes, each of which was about 12 feet long, were found in the bed of the lake on the south-west side of the crannog.

A double-bladed oak paddle, 4 feet 8 inches long and 5½ inches broad, and a large oar, together with the blade portion of another, were found amongst the *débris* on the crannog.

V.—*Objects of Metal*

(*a*) The chief articles made of iron are the following:—

1. A gouge, 8 inches long.

2. A chisel, 10 inches long. Both these tools had remains of bone or horn handles containing beautiful green crystals of vivianite.

3. Two knives. One has a blade 6 inches long, and a pointed portion for being inserted into a handle. It was found on a level with, and close to, the lowest hearth, along with fragments of its handle made of stag's horn. The other, found by a farmer in the *débris* long after it was thrown out of the trenches, was hafted on a different plan from the former, the end portion being broad, and riveted to its handle by four iron rivets, which still remain.

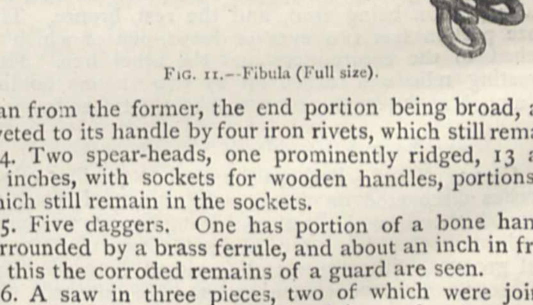


Fig. 11.—Fibula (Full size).

4. Two spear-heads, one prominently ridged, 13 and 9½ inches, with sockets for wooden handles, portions of which still remain in the sockets.

5. Five daggers. One has portion of a bone handle surrounded by a brass ferrule, and about an inch in front of this the corroded remains of a guard are seen.

6. A saw in three pieces, two of which were joined when found, and the third was lying a few feet apart. The length of the three portions together is 38 inches, and the average breadth is 3 inches.

7. A small corroded iron hatchet, with portion of a wooden handle in the socket.

8. A curious three-pronged implement was found, about 3 feet deep, in the large drain a few yards to the south of the crannog; the prongs are curved, very sharp at the points, and attached laterally; they are 2½ inches apart, and 4 inches long.

(*b*) Of articles made of bronze or brass, the following may be noted:—

1. Two fibulæ—one of which is figured here (Fig. 11)—were found about the centre of the refuse heap, and a third, much more elaborately ornamented, was subsequently found in the *débris* when closing up the trenches.

2. A bronze ring pin, 6 inches long. The square-shaped portion of the top has a different device on each side, one of which is a fylfot (croix gammée or swastika), and the shank from its middle to the point is ornamented on both sides (Fig. 12).

3. A spatula or dagger-shaped inplement with blunt edges, measuring 11¼ inches long and 1½ inch broad.

4. A thin spiral finger-ring.

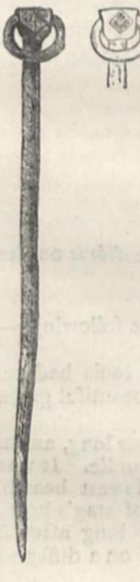


FIG. 12.—Bronze Ring Pin (Scale ½).

FIG. 13.—½ size. Made from stems of a moss (*Polytrichum commune*).

5. A bridle-bit. This consists of two large rings and a centre-piece. Its extreme length is 10½ inches; the outer diameter of the rings is rather less than 3 inches, and the centre-piece, which is entirely made of iron, is 3¾ inches long. The rings are partly iron and partly bronze, the circular portion being iron, and the rest bronze. The bronze portion has two eyes or loops, one of which is attached to the centre-piece and the other free. This interesting relic was turned up by two visitors poking with a stick at the south-east corner of the refuse heap.

VI.—*Miscellaneous Objects*

1. *Carved Wood.*—Perhaps the most interesting of all the relics discovered on the crannog is a small piece of ash-wood, about 5 inches square, having curious diagrams carved on both sides. On one side three equidistant spiral grooves, with corresponding ridges between, start from near a common centre and radiate outwards till they join, at uniform distances, a common circle which surrounds the diagram. On the other side is a similar diagram, with this difference, that between the points of commencement of the spiral grooves there is a space left which is occupied by a small circular groove surrounding the central depression or point. This figure is surmounted and overlapped by two convoluted and symmetrical grooves meeting each other in an elevated arch, with a small depression in its centre. The relic was found on the west side of the crannog, about 4 feet deep, and near the line of the horizontal raised beams.

2. *Fringe-like Objects.*—Another object which has excited considerable curiosity is an apparatus made like a fringe by simply plaiting together at one end the long stems of a kind of moss. Portions of similar articles were found in three different parts of the crannog, and all deeply buried. The one figured here, and the most neatly formed, was found in the relic bed near the hearths (Fig. 13).

3. Among the remaining articles under this head are to be found some portions of leather, one thick bit being pierced by stout copper nails; a few glass beads and small rings made of bone; some fragments of pottery, one being the bottom of a jar, said to be Samian ware; portions of three armlets made of jet or lignite, together with one or two other fragments of objects made of the same material.

According to a report by Prof. Rolleston of Oxford, who kindly undertook the examination of the bones and horns collected on the crannog, the following animals have their skeletons represented:—The ox (*Bos longifrons*); the pig (*Sus scrofa*, variety, *domestica*), the sheep, old dun-faced breed (*Ovis aries*, variety *brachyura*); the red-deer (*Cervus elaphus*), very abundantly; the roe-deer (*Cervus cipreolus*), scantily, though unambiguously; the horse (*Equus caballus*) is represented by only one shoulder-blade; and the reindeer (*Cervus terandus*) by one or two fragmentary portions. Some of the bones and horns had their cavities filled with beautiful green crystals, which on analysis proved to be vivianite.

Among the specimens of wood used in the structure of the island Dr. Bayley Balfour has identified the following:—Birch, hazel, alder, willow, and oak. In addition to these some of the relics were found to be made of elm and ash. ROBERT MUNRO

THE UNITED STATES WEATHER MAPS, AUGUST, 1878

THE most remarkable feature of the meteorology of the northern hemisphere for August, 1878, as compared with July preceding, was the enormous change which took place in the distribution of amospheric pressure over the Atlantic as far as lat. N. 60°, the change being greatest in the region around Ireland and the south-west of England, where it amounted to a fall of about the third of an inch. Pressure was also still further reduced over nearly the whole of the United States, particularly in the north, the deficiency from the normal at New York being 0·150 inch. In Europe this lowering of the pressure extended eastward into Russia as far as long. E. 40°, where it rose to nearly the average. It again fell on advancing further eastwards to 0·150 inch below the normal in the valley of the Irtish, rising however again to the normal over the western affluents of the Lena. Thus from the Rocky Mountains, across the United States, the Atlantic, Europe, and into Asia as far as the Lena, pressure was under the normal, in other words over a broad belt going half-way round the globe. This region of abnormally low pressure would appear to have stretched south-south-westward from Western Siberia, embracing the regions marked off by Syria, Egypt, Africa as far as Cape Colony, the Mauritius, Western India, and Turkistan. Also in Victoria, Tasmania, and New Zealand pressure was very low, being at Dunedin 0·372 inch less than the normal.

On the other hand, pressure was above the normal in the region of the Rocky Mountains, over South Greenland, Iceland, Farö, Shetland, and adjacent coasts of Norway;

about the normal over a limited patch of country lying to the north-west of the Caspian, and over the whole of Asia to the east of a line drawn through Ceylon, the Upper Ganges, and Lake Baikal, this latter area of high pressure extending as far south over Australia as Adelaide. Another area of high pressure spread from Central America eastwards across the West Indies, the north of South America, and the Atlantic to Africa.

In accordance with this distribution of pressure temperature was from one to two degrees above the normal in the United States, except in the north-east, where it fell to the average in the New England States, and fell still further to 1°·6 below it at St. John's, Newfoundland. Under the influence of the low pressure around Ireland the Weather Map shows a prevalence of strong breezes from the Atlantic over Western, Central, and Eastern Europe as far as Kiev, and over the whole of this wide region temperature was above the normal, most notably so over Great Britain and the south of Norway, the mean at Mandal being 4°·2 above the average.

Over England these Atlantic breezes were south-westerly, but in Scotland easterly. In England the month was one of the rainiest Augusts on record, and in the east of Scotland the rains were also unusually heavy. On the other hand, what invariably happens when the weather in the east of Scotland is characterised by rain and east winds, the weather of the West Highlands was dry and bright.

The comparatively insignificant region of higher pressure to the north-west of the Caspian, taken in connection with the markedly low pressure in Western and Central Siberia, exerted a striking influence on the weather of that region, since, owing to the northerly winds, which necessarily set in with stronger force than usual, temperatures fell to from two to three degrees below the normal from the Irtish to the Dnieper. On the other hand, over Northern Asia, to the east of long. 75°, temperatures above the average prevailed, the excess at Irkutsk being 3°·0. In Victoria, pressure being lower on the coast than in the interior, northerly winds set in, and under their influence the temperature of the colony rose generally to 1°·5 above the normal. In New Zealand pressure was not only very low, but diminished greatly from west to east over the islands, and owing to the strong westerly winds which accompanied this distribution of the pressure, the temperature fell generally 2°·5 below the average of this winter month.

THE IRON AND STEEL INSTITUTE

FOLLOWING close upon the Institution of Mechanical Engineers came the meeting of the Iron and Steel Institute. The bill of fare of the younger association was certainly longer, and will probably be found not less interesting, than that of its elder colleague. It contained eleven papers on subjects of practical importance connected with the nature and manufacture of iron and steel. All of these papers were valuable, five of them especially so, and they prove beyond a doubt that the Iron and Steel Institute is doing immense service to metallurgical science in collecting and systematising practical information, and in affording opportunities for the discussion of theoretical opinions.

It was naturally to be expected that the recent meeting would furnish some information as to the practical working and commercial success of the Thomas-Gilchrist process of producing Bessemer steel from inferior brands of pig-iron, and especially from those descriptions, like Cleveland pig, which are rich in the very deleterious ingredient, phosphorus. At the last spring meeting of the Institute this process was little more than an idea, but it was clearly seen that if it could be rendered a commercial success its influence on the future of the North-Eastern iron district of this country could not fail to be enormous. Accordingly we are not surprised to find two papers on this subject, one by Messrs. Holland and Cooper, of Sheffield, entitled "On the Manufacture of Bessemer Steel and Ingot Iron from Phosphoric Pig," and the other by Mr. R. Pink, of the Hœrde Works, Westphalia, "On the Dephosphorisation of Iron in the Bessemer Converter." From these two papers we learn the most recent results of British and German experience, and it must be deemed a matter of great congratulation that in both countries much good progress seems to have been made in the practical working of the new process.

The difficulties encountered were only such as are always encountered in the introduction of any new method. The first of these minor troubles experienced in Sheffield was to find out the right moment when to stop blowing. "It seemed doubtful whether it would be practicable (having no definite point at which we could safely stop blowing, corresponding to the drop of the carbon flame in the ordinary process) to burn out the whole of the phosphorus regularly, without sometimes carrying the process too far, and thereby oxygenating the charge. And this, as all steel makers will agree, is very apt to give trouble." However, by taking samples of the metal from the converter during the "after-blow," and testing them, it was found practicable to stop the process at the right time, and to remove the phosphorus in a very satisfactory manner. Here, however, a new difficulty arose. The time lost while the samples were being taken enable the slag and metal to accumulate at the "nose" of the converter, and partially choke the aperture, thus causing great inconvenience and loss of time in removing the obstruction. By reducing the area of the aperture, and thus retaining the heat better in the converter, and by lining the nose with fire-brick, this difficulty was partially got over, but the accumulations of slag still continued at the junction of the fire-brick and bassic lining of the converter. Increased experience, however, soon enabled the Sheffield manufacturers to complete the blowing by timing with a watch, without the testing of samples, and as no time was given for the accumulation of slag, no further trouble was experienced. How completely the timing system answered may be judged from the following extract from Messrs. Holland and Cooper's paper:—"In the week ending April 17, when not a single sample was taken during the operation, except in the case of the experimental blow 748, the average amount of phosphorus contained in 36 blows, all of which were analysed, was ·056 per cent., the highest being ·101 per cent., and the lowest ·019 per cent." The composition of this quality of steel has been in other respects very regular, the analyses and results of a test piece 2 inches long and ·533 inches in diameter being as follows:—

Carbon.	Silicon.	Sulphur.	Phosphorus.	Manganese.	Breaking strain, tons.	Elongation per cent.	Reduction of area per cent.
·40	—	·040	·085	·662	39·75	20·25	31·84

It has been found that since sampling has been dispensed with, that the wear of the lining of the converter is very uniform. As many as 630 tons of steel have been produced from one lining, without any repairs excepting a new fire-clay brick-lining for the nose; and 270 tons more were got from the same lining after renewing the front or blowing side, and putting in a new nose. This absence of difficulty about the renewal of the plant, coupled with the excellent quality of the metal produced, show that the process must now be pronounced a commercial success.

The experiences of the Sheffield manufacturers were amply borne out by the results arrived at at Hœrde. Mr. Pink says in the beginning of his paper: "Without doubt we are on the verge of making from the *very worst classes of pig iron a most reliable and remarkably cheap steel*," and this assertion is amply borne out by the results of chemical analysis and mechanical testing which he publishes. "In the softer qualities for plates, wire, &c., it is at times astonishing what results are obtained. With 37 to 40 kilogrammes of actual breaking weight, as much as 70 per cent., and in some cases even 75 per cent. of contraction has been reached. At the same time this ingot iron can take very high heats, forging and rolling without a flaw. The production of this especial quality is so simple, the cheapness of the raw material, the certainty in working, its softness, and its ductility, all point to its driving at no very distant date puddled iron plates out of the market. For wire even of the smallest gauges it has been declared better than that drawn from billets puddled from charcoal pig."

This is an extremely good result to have attained in the short space of less than a year, and gives good ground for the hope of further improvement in the future. The manufacturers do not appear as yet to have quite succeeded in producing a hard steel by this process.

The remainder of Mr. Pink's paper contains an account of very similar difficulties experienced and overcome to those described by Messrs. Holland and Cooper.

A paper of considerable practical interest was read by Mr. Henry Simon, C.E., of Manchester, "On an improved System for the Utilisation of Bye-Products in the Manufacture of Coke." It is well known that in the manufacture of gas for lighting purposes the sale of the bye-products, such as tar and ammoniacal liquor, which are obtained during the distillation of the coal, is one of the chief sources of profit. In the manufacture of coke it has hitherto been the practice in this country to allow the tar and ammoniacal liquor to run to waste. Such a course not only causes waste, but increases the great nuisance of coke ovens to the neighbourhood in which they are planted. The extent of the waste may be inferred when it is stated that at Manchester the gas-works obtain 38*s.* per ton for tar, and from 20*s.* to 25*s.* per ton for their ammoniacal liquor; and it has been found at Bessèges, in France, where the bye-products are saved, that every ton of coke obtained gives nearly 3 cwts. of ammoniacal liquor, and 72½ lbs. of tar, worth together, at Manchester prices, about 4*s.* 6*d.* per ton of coke produced.

In this country over 7,000,000 tons of coke a year are produced for the manufacture of pig-iron alone, the value of the bye-products of which is about 1,350,000*l.*, a sum which is annually lost to the nation. The demand for the ammoniacal liquor, both for agricultural purposes and for the manufacture of soda, is practically unlimited. As an instance of the truth of this statement it may be mentioned that one firm of soda-manufacturers, viz., Messrs. Solway, have contracted for the whole production of the Bessèges Works, and transport it 300 miles by rail to their factory near Nancy.

By the new method of production nearly the whole of the noxious effect of the old "beehive" coking ovens is done away with. So great are these ill-effects that in the words of the Royal Commission on noxious vapours, which sat in 1877, "all vegetation near coke ovens, conducted on the older methods, suffers severely. The growth of trees is checked or destroyed, fences are killed, crops of every description are injured, cattle suffer, and upon many occasions the effect of the vapours emitted by coke ovens is terrible." In the counties of Durham and Northumberland alone 6,000,000 tons of coal are annually coked, and in the process give off 2,000,000 tons of vapours, which consist in great part of the valuable tars and nitrogenous compounds which might so easily be saved. The quantity of sulphurous acids which escape into the atmosphere every year in these districts is estimated to be about 70,000 tons.

In the process described by Mr. Simon "the coal is rapidly carbonised by subjecting a comparatively thin layer of it to a high temperature in a closed and retort-like vessel, and whilst in the beehive ovens the volatile products are burned inside, we burn them around the outside of this retort-like vessel, and only after they are deprived of the tar and ammoniacal liquor." Besides saving these products, the heat of the hot gases is utilised greatly for the production of steam. At Bessèges about 45 pounds of water is evaporated into steam of 4½ atmospheres pressure per hour and per ton of coal coked; and it is said that under more favourable circumstances 59 pounds might be evaporated. The remainder of the paper contains a technical description of the new apparatus, the advantages of which are stated to be as follows:—

"1. Greater yield of coke by about 10 per cent.

"2. Greater purity of coke.

"3. A yield of about 4*s.* worth of useful bye-products per ton of coke.

"4. An almost entire absence of smoke or noxious vapours.

"5. In comparison with any other existing system of coke ovens, equal facilities for utilising the heat, and a reduced cost for repairs."

Messrs. John Parry and Alexander Tucker read a joint paper "On the Application of the Spectroscope to the Analysis of Iron and Steel." They commenced by noticing that the analysis of iron and steel is usually summed up in percentages of iron, manganese, carbon, silicon, sulphur, and phosphorus, and perhaps copper, nickel, and cobalt, and suggested that other elements might also be at work, and that we ought not to remain satisfied with percentages of the above substances till we have proved the absence of others. It has, however, been found extremely difficult to prove the absence of the rarer elements, partly because the traces of these latter are apt to accompany the large mass of iron throughout the chemical processes. Under these circumstances it was thought that the spectroscope, which has done so much good work in other departments of chemistry, might be usefully employed.

"Theoretically a well-focussed photographed spectrum of a steel should be an unerring index to its composition; this is partly true in practice, but it is not in our experience absolutely so." "We have found the spectra of pure iron, Bessemer steel, tool steel, chrome steel, Siemens' steel, and pig iron to be decidedly different, and the differences would be characteristic, but they failed to show the presence of bodies which further experiment proved to exist." "There are several reasons why this should be the case.

"1. The number of lines due to iron is so great (100-130) that they overlap in the small spectra the lines due to other bodies, and our apparatus does not readily allow of images larger than one or two inches being taken.

"2. The intensity of light due to the traces of bodies may not be sufficient to record lines on the plate.

"3. Because of the variation in the volatility of the elements, and therefore the necessity of variation in the intensity of the spark."

The authors therefore thought it important either to separate the iron or considerably lower its percentage, and the solution of this problem was their principal aim. The results of their experiments have led them to believe that as a rule the quantity of iron is much over-estimated. In confirmation of this opinion they also quote the fact that iron and steel are capable of absorbing twenty times their volume of hydrogen, a quantity which is always omitted in ordinary analysis, "which is probably due to the fact that a steel saturated with hydrogen must be less liable to oxidation in the heating furnace than one containing little or none. In order to eliminate the iron a method of digestion with various solvents was adopted. By this process much larger quantities can be operated on at a time than by the ordinary methods of precipitation. As much as 7,000 grains of Bessemer steel were dissolved in *aqua regia*. The solution was evaporated and heated in a paraffin bath till the acids were driven off. Ammonia was then poured on and allowed to act under pressure for several hours. It was then filtered off and evaporated to dryness with nitric acid, so as to decompose any ammonia salts. The residue was then treated in three different ways, and the spectrum photographed in each case.

1. With excess of hydrochloric acid. 2. Water was added to the iron and boiled with it. 3. Acetic acid was added and boiled with the iron, some of which was dissolved, and the solution was therefore nearly neutralised with ammonia and boiled. Photographs were then taken of the spectra of the iron thus precipitated and the filtrate from it. The following is a summary of the results obtained :—

Ammonia.	Water.	Acetic Acid.
Nickel	Calcium	Antimony
Cadmium	Manganese ...	Lead
Calcium	Copper	Aluminium
Manganese ...		Copper
Copper		Calcium
		Manganese

"The above experiments were made with 7° coils and dense prisms of 60° and 75°, with object-glasses of quartz. By using an electro-dynamic machine a greater dispersion might be used, and the length of the image increased. We think that it would then be found that the bodies which we have detected by indirect means would appear in the spectrum of the original metal."

In addition to the above Mr. Wrightson read a second paper "On some physical changes occurring in Iron and Steel at High Temperatures," which was a continuation of a paper read by him at the Liverpool meeting last year. Mr. Ackerman, of Stockholm, contributed a very lengthy memoir "On Hardening Iron and Steel; its Causes and Effects." There were also five other papers on subjects of importance, chiefly to those technically interested in the manufacture of iron and steel.

In conclusion the Institute must be congratulated not only on the importance and number of the papers produced, but also on the fact that it has succeeded in obtaining contributions from three foreign countries, viz., Germany, Russia, and Norway, a circumstance which will no doubt give to the proceedings of the association an international importance.

NOTES

Mr. W. Chandler Roberts, F.R.S., Chemist of the Mint, has been appointed to the Lectureship of Metallurgy in the Royal School of Mines, rendered vacant by the resignation of Dr. Percy, F.R.S. Mr. Roberts will continue to hold his appointment at the Mint. Mr. Richard Smith, hitherto Assistant Metallurgist, has been appointed Instructor in Assaying.

The following foreign men of science have recently (May 6) been elected Foreign Members of the Linnean Society :—M. C. J. de Maximowicz, Director of the Imperial Museum and Herbarium, St. Petersburg, author of many important memoirs on systematic botany; Dr. Edward Strasburger, Professor of Botany in the University of Jena, well known for his morphological and physiological researches among various groups of plants; and Prof. Elias Metschnikoff, Director of the Embryological and Zoological Institute, Odessa, whose investigations on the structure and development of the lower marine invertebrata are highly valued.

The Municipality of Rome has just erected on the promenade of the Pincio a statue in honour of Father Secchi. The statue represents the great astronomer in the attire of a member of the Company of Jesus.

Under their present government the French are multiplying the statues erected to their men of science by means of public subscription. Not less than three new schemes are on foot for that purpose in several parts of the country. A committee has been established at Montpellier for Auguste Comte; another at Blois, in honour of Denis Papin, a rival of the Marquis of Worcester, who, according to the French notion, invented the steam-engine; and a third at Bar-le-Duc, on behalf of François Cugnot, an engineer born in the vicinity of that city, who in 1770 constructed a road-locomotive. This rudimentary steam-engine, which is exhibited just now at the Conservatoire des Arts et Métiers, was tried officially but unsuccessfully in the arsenal of Paris more than a century ago.

Dr. Nils Johann Andersson, the celebrated Swedish botanist and traveller, as the *Gardener's Chronicle* learns from the *Botanisches Centralblatt*, died after long suffering on March 27 at Stockholm. Andersson was born on February 20, 1821, studied at Upsal, graduated as Doctor of Philosophy in 1845, and resided at the University as Assistant Professor of Botany. Afterwards he took part in the expedition of the frigate *Eugénie* round the world, 1851-1853, the result of which he published in several treatises which were translated into various foreign languages. In 1855 he became Demonstrator of Botany at Lund, and in the following year was appointed permanent Professor of Botany, Director of the Bergianska 'schen Garten and Superintendent of the botanical division of the Royal Museum. There he worked with great success till the beginning of 1879. From here Andersson undertook numerous journeys in the cause of science to Lapland, Norway, Germany, France, England, &c. He also acquired scientific renown through his various treatises, books of travel, and text-books.

Prof. Silvestri, of Catania, reports as follows concerning the renewed activity of Etna, to which we referred last week :—"The eruption issues from the western side of the mountain, precisely the part which separates the central crater from the eruptive craters of last year. The situation indicated represents the principal part of the ravine which was then formed and remained opened, and which, beginning at the recent eruptive craters, finally crosses the great crater. This ravine, in which are many crater-caverns which opened last May but remained inactive, is now the scene of the present activity, limited as yet to a simple eruption of steam and ashes, such as has frequently taken place during the past months at the summit of the mountain. To-day (April 28), while the sky is cloudless, one sees from Catania the summit of Etna enveloped in clouds which, scattered by a rather strong north-east wind, have no resemblance to eruptive clouds, though they are formed by the steam issuing from the mountain. The eruption of mud at Paterno to the south still continues, and on certain days in some of the craters increases in energy, ejecting as abundant mud as during the first days after the appearance of the phenomena."

On Tuesday evening a paper on the botanical enterprise of the empire was read to the Colonial Institute in St. James's Hall by Mr. Thiselton Dyer, assistant director of Kew Gardens. The lecturer gave a history of botanical gardens, which date from the middle of the sixteenth century, when Alfonso d'Este, Duke of Ferrara, the patron of Tasso, set the fashion of making collections of foreign plants and flowers. The earliest public botanic garden was founded by Cosmo de' Medici in 1544 for the University of Pisa. The following year one was founded at Padua. In France the earliest botanic garden was founded at Montpellier towards the end of the sixteenth century, and in Germany that of Giessen was established in 1614, and in the Low Countries that of Leyden dated from 1577. In England the Royal Garden at Hampton Court was founded by Queen Elizabeth, and supported by Charles II. and George III. Those which followed and still remain were Oxford, founded in 1632; Chelsea, in 1673; and Edinburgh, in 1680. The origin of Kew as a scientific institution was entirely due to our Hanoverian princes. During the reigns of George IV. and William IV. Kew was much neglected; but since that date, owing to the efforts of Lindley and Sir W. Hooker, that state of things had been remedied. The lecturer gave a long and elaborate account of the methods pursued and the objects aimed at in the gardens at Kew. There was hardly any country of which a native would not recognise some types of vegetation with which he had been familiar. Plant distribution to all parts of the world was extensively carried out from the gardens, especially that of cinchona, caoutchouc, and Liberian coffee. The herbarium, which was the largest and best organised in the world, and the library, were important features in the gardens, and served to promote a scientific method of nomenclature, identification, and classification. In 1863 the Duke of Newcastle, then Colonial Secretary, instructed Sir W. Hooker to publish a series of colonial floras; and twenty-two volumes had been issued and others were in progress. The floras of Australia and British India were especially valuable. In the former there were 293 species of acacia and 135 of the eucalyptus. Floras had also been published of Hongkong, Mauritius, and the Seychelles, the British West Indies, and New Zealand. The example of Kew in the matter of museums and economic botany had been followed by Hamburg, Berlin, Ghent, Paris, Boston, and our own colonies. The whole vegetable collections of the India Museum had been recently transferred to Kew. One of the most striking features of the gardens was the enormous correspondence with the botanic establishments of the colonies. Mr. Dyer then indicated the principles which should guide the establishment of a colonial botanic garden; one of the chief of these was that it should be attractive and conveniently situate. It was also most important that it should be under competent management, and he was glad to see that the emoluments of directors had in some of our colonies been fixed on a liberal scale. Mr. Dyer concluded by reviewing the progress made by our colonies in botanical research.

IN the first four months of 1880 the receipts for telegrams in France have been increased by 1,500,000 francs, but the postal department lost one-sixth of that amount. This result shows that owing to the low rate of telegrams in France (½*d*. per word) and the increased postage (1½*d*. per letter), telegraphy is gradually taking the place of ordinary letters.

MR. S. H. WINTLE contributes to the *Launceston Examiner* (Tasmania) of Feb. 20 some curious facts with regard to a "black snake" which he succeeded in capturing by pinning to the ground with a forked stick. In his haste Mr. Wintle pinned the snake to the ground by the middle of the body; what then occurred we give in his own words without comment:—"No sooner had I done so—for now his rage was at its highest pitch—than in an instant he buried his fangs in himself, making the spot wet either with viscid slime or the deadly poison. Now comes that which is of most interest from a scientific point of view. He had hardly unburied his fangs when his coils round the stick suddenly relaxed. A perceptible quiver ran through his body, and in much less time than it takes to write it he lay extended and almost motionless, with his mouth opening and shutting as if he were gasping, but no forked tongue thrust out. In less than three minutes from the time he bit himself he was perfectly dead. Here, then, was a striking example of the potency of the fang-poison of the snake upon itself." An hour after the death of the snake Mr. Wintle tried the effect of the poison in the fangs on a mouse, which died in five minutes, and on a lizard, which died in fourteen minutes. On a *post-mortem* examination of the snake the body was found almost bloodless, "as though the action of the poison had destroyed the colouring-matter of the blood."

MR. F. LEWIS, jun., of Ballangoda, Ceylon, sends us a snake story in connection with the correspondence on intellect in brutes:—"A short time ago," he says, "I caught a common 'green snake,' and, anxious to try its power of intellect, I brought my finger close to its nose, and seeing that it seemed disposed to bite, I introduced the end of a match close to its mouth. This it did not seem to care about touching, so thinking perhaps that if I moved it about before the animal's eyes it might attract its attention, I did so, but without success. I then took the animal by the neck, and brought *its own tail* before its nose. This it grasped at immediately, and with considerable ardour, but still refused the match! Why should the snake prefer its own tail upon which to exercise its temper? I would suggest that if a few experiments were tried on animal instinct or intelligence some remarkable facts might be elicited, and probably some light thrown upon a subject at present so intricate and complex."

ON Tuesday next (May 18) at the Royal Institution Mr. J. Fiske will give the first of a course of three lectures on American Political Ideas viewed from the Standpoint of Universal History; on Thursday (May 20) Mr. T. W. Rhys Davids will give the first of a course of three lectures on the Sacred Books of the Early Buddhists. The following are the arrangements for the remaining Friday evenings: May 21, Mr. W. Spottiswoode, on Electricity *in transitu*; May 28, Mr. Francis Hueffer, on Musical Criticism; and June 4, Mr. H. H. Statham, an Analysis of Ornament.

M. W. DE FONVIELLE has discovered a very simple process for putting in rotation his newly invented electro-magnetic gyroscope. It is sufficient to connect one end of the frame with each part of the self-acting interrupter. The only difficulty is to place the magnets at a proper distance and not to use a stronger voltaic current than required. For this operation to succeed, it is desirable to understand well the manœuvres of an instrument constructed on purpose. Some of the so-called electro-medical bobbins succeed remarkably well, either with the primary, the secondary, or a combination of the two working in tension.

A PART of the St. Gothard Tunnel, 6,300 metres from the south entrance, has fallen in, killing three workmen and injuring three others.

FIVE walled tombs, each containing a skeleton, have been discovered at Chamblandes, Canton Vaud. From the absence of metal ornaments and other indications, they are supposed to belong to an age prior to that of bronze.

ON May 9 a large number of officials and others assembled at Noailles to celebrate the completion of a rural railway with narrow gauge, of which we mentioned the inauguration a few months ago. The speculation is succeeding very well, and great improvements have been realised in all the surrounding country since the system has been in operation.

THE additions to the Zoological Society's Gardens during the past week include a Silver-backed Fox (*Canis chama*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Tayra (*Galictis barbara*) from South America, presented by Mr. G. A. Muhlhaüser; an Indian Chevrotain (*Tragulus meminna*) from Ceylon, presented by Mr. W. H. Ravenscroft; a Ruddy Ichneumon (*Herpestes smithi*) from India, presented by Mr. A. R. Lewis; two Slow-worms (*Anguis fragilis*), British, presented by Mr. O. Thomas; five Bosca's Mud Newts (*Pelonectes boscai*) from North Spain, presented by Dr. A. Günther, F.Z.S.; an Indian Cobra (*Naia haje*) from India, presented by Mr. W. R. Higham; a Macaque Monkey (*Macacus cynomolgus*) from India, a Goffin's Cockatoo (*Cacatua goffini*) from Queensland, deposited; four Upland Geese (*Bernicla magellanica*) from Patagonia, purchased; an Axis Deer (*Cervus axis*), a Zebu (*Bos indicus*), born in the Gardens.

GEOGRAPHICAL NOTES

IT is a great relief to learn that a letter has been received at St. Petersburg through Pekin from Col. Prejevalsky, dated from the town of Si-Ning, March 20, announcing that the expedition under his command is safe. He left the Nan Shian mountains in July, and entered Thibet through Shaidash. His party were attacked by Tanguts, of whom they killed four and put the remainder to flight. The Thibetian troops stopped the progress of the expedition 250 versts from Hlassa, and a messenger from the Grand Lama of Thibet brought the refusal of the Thibetian authorities to allow the Russians to proceed. The latter were, therefore, obliged to return, which they did with some difficulty through Northern Thibet, wintering at a height of 16,000 feet above the level of the sea. Col. Prejevalsky expects to reach Kiakhta in August by way of Alashan Urgu.

AT the meeting of the Geographical Society on Monday last, Mr. Everard F. im Thurn, late of the Georgetown Museum, read a paper nominally descriptive of one of his journeys into the interior of British Guiana, but which also furnished much interesting information about that country generally. Mr. im Thurn first gave an account of the four tracts, parallel to the sea-coast, into which British Guiana may be divided, and afterwards of his journey up the Essequibo to the Savannah tract, over which he passed into Brazilian territory. At the Warraputa Cataracts he saw for the first time the rock-pictures which form so strange an addition to the landscape in parts not only of South, but of North America. The figures represent men, monkeys, snakes, &c., and are on a small scale. These pictures in Guiana are not of one kind, some being cut deeply into the rock, while others are merely scratched on the surface. Mr. im Thurn speaks well of the climate of British Guiana away from the coast, the chief drawbacks in the interior being fever, not of a dangerous kind, diarrhœa, and ophthalmia, the germs of the last being probably conveyed by the countless small flies with which the country is infested. His allusions to the flora of the region were particularly interesting, and from a remark which he made we are glad to believe that we shall have a book from his pen before long on this little understood colony. Mr. Flint, who had been Mr. im Thurn's companion, afterwards gave a brief description of an expedition he had made to the Roraima Mountain on the western frontier of British Guiana. He does not believe in the reported inaccessibility of this wonderful mountain, and roundly asserted that no serious attempt had yet been made to ascend it, previous travellers not having approached within a considerable distance of its base.

MR. DOUGLAS W. FRESHFIELD, writing to the *Times*, states that further letters have been received from Mr. E. Whymper, announcing his ascent of Pichincha and his meeting with M. Wiener, who is about to explore the Napo country. Fuller and more formal accounts of Mr. Whymper's exploits have been received, but by his request they will not be made public until after his return in June.

IN continuation of our note (NATURE, vol. xxi. p. 526) on Mr. Easton's journey in the extreme north-west of China, we learn from a further instalment of his diary some additional particulars respecting his travels. After leaving Shunhwa-ting on the upper waters of the Yellow River, he intersected at right angles the longitudinal range of mountains that runs along the north bank, and after a hard climb of fifteen miles he reached Ba-rung, a small mud-walled town under the jurisdiction of Sining. The hills are of mud, and landslips have split them in all directions; they are uncultivated, and scarcely a blade of grass is to be seen. An extensive view was obtained from the top, and far away on the western horizon were seen snow-capped peaks of high mountains. Sining-fu, where Col. Prejevalsky is believed to have fixed his head-quarters for the present, was afterwards visited, and this city is described as "rather large and oblong, but really a very shabby place;" it is stated to be 400 miles distant from Tsinchow-fu, the head-quarters of the China Inland Mission in the interior of the Kansu province. On his return to that place from Sining, Mr. Easton crossed the Yellow River near Sinchêng, about 100 miles from Sining, and he describes its width at that point as about 100 yards, but further down it widens to about 150 yards. The river winds very much, and abounds in rapids.

WHERE at one time, says the Eureka *Leader*, was Ruby Lake, there is at present not a drop of water. This sheet of water, seven or eight years ago, was from eighteen to twenty miles in length, and varied in breadth from half a mile to two or three miles, and was in a number of places very deep. It was fed by numberless springs along the foot of Ruby Mountain, and was the largest body of water in Eastern Nevada. For a number of years past it has been gradually drying up, until at last it has entirely disappeared. What has been the cause of this is a mystery. The Ruby range of mountains is considered the largest and finest between the Rockies and the Sierra Nevadas, and besides being well wooded, has been the best-watered range of mountains in Nevada.

A PARTY of United States engineers has recently taken soundings of the Niagara River below the falls. It was a work of great difficulty to approach the falls in a small boat. Great jets of water were thrown out from the falls far into the stream, and the roar was so terrible that no other sound could be heard. The leadsman cast the line, which gave 83 feet. This was near the shore. Further down stream a second cast of the lead told off 100 feet, deepening to 192 feet at the inclined railway. The average depth of the Swift Drift, where the river suddenly becomes narrow with a velocity too great to be measured, was 153 feet. Immediately under the lower bridge the whirlpool rapids set in. Here the depth was computed to be 210 feet.

THE German African Society, in the last number of its *Mittheilungen*, publishes a list of all the scientific expeditions sent out by the (former) German Society for the Investigation of Equatorial Africa, and by the new Society (under its present title) during the years from 1873 to 1879. Altogether there were no less than eight expeditions, viz.:—1. The Loango-Expedition, and to the Chinchoxo Station, 1873-1876; cost 10,532*l.*, less 1,133*l.* realised from sale of specimens; leader, Dr. Paul Güssfeldt, not Prof. A. Bastian (who took part at his own expense in the preparatory steps for the establishment of the Chinchoxo Station). 2. The Ogowe-Expedition of Dr. Oscar Lenz, 1874-1876, cost 1,563*l.* 3. Cassange-Expedition, 1874-1876, cost 4,457*l.* Members: Capt. A. von Homeyer, Dr. Paul Pogge, Herm. Soyaux, Lieut. A. Lux. 4. Eduard Mohr's Expedition, 1876, cost 692*l.* 5. Engineer Schütt's Expedition, 1877-1879, cost 2,590*l.* 6. Dr. Max Buchner's Expedition, since 1878, cost (till October, 1879) 1,523*l.* 7. Rohlfs' Expedition, since 1878, cost (till October, 1879) 2,255*l.* Members: Dr. Gerhard Rohlfs, Dr. Anton Stecker. 8. Dr. Oscar Lenz's Expedition to Marocco, since the end of 1879.

IN his just published report on Borneo H.M.'s Consul-General says that owing to its geological formation the soil of the island cannot be compared with that of Java, Sumatra, the Sulu Archipelago, and the Philippines, all islands of volcanic origin. Towards the north, however, and in the plains in the neighbourhood of the Great Kina Balu range, the soil is exceedingly good, as is shown by the success with which the natives grow in their rude manner rice, tapioca, indigo, &c. At present the greater part of the island is clothed with a dense primæval forest of lofty trees, many of which afford excellent timber, and until the virgin soil thus covered has been cleared it is useless to speculate on the mineral resources of the country, but there is no doubt of the existence of coal, antimony, ore, and gold in Northern Borneo. Mr. Treacher, we may add, accompanies his report with a useful sketch-map of this part of the island.

DR. DUTRIEUX, who until quite lately was on the staff of the first Belgian expedition to East Central Africa, has just published at Brussels (Lebègue et Cie.) some of the results of his observations in that country, under the title of "La Question Africaine au point de vue Commerciale."

IN a communication, entitled "Cimbébasie," in the last number of *Les Missions Catholiques*, Père Duparquet furnishes a good deal of interesting information respecting Ovampo-land in Western Africa. Père Duparquet gives, in fact, a rapid sketch of his explorations from Olokonda to Quanhama in about 17° S. lat., 16° E. long. He has besides, however, collected a mass of notes about a large tract of country hitherto almost entirely unknown, and of which he expresses a high opinion.

THE new number of *Les Annales de l'Extrême Orient* is chiefly occupied with an instalment of Prof. P. J. Veth's notes on the languages and literature of Java, and the interminable question of M. J. Dupuis and Tongking.

IN the new number of the *Verhandlungen* of the Berlin Geographical Society (Band vii. No. 3) Herr Flegel gives an exceedingly interesting account of his residence in West Africa, his visit to the Cameroon Mountains, and his ascent of the river Binué.

THE *Bolletino* of the Italian Geographical Society for April contains full details of the proposed Arctic Expedition under Lieut. Bove, with a carefully compiled map of the south polar regions so far as these have been hitherto explored.

M. DESIRÉ CHARNAY has left New York for Mexico for the purpose of carrying out a thorough exploration of the ancient remains that still exist in that country. It is expected that the work of exploration will last for two or three years.

ON ELECTRIC LIGHTING[1]

DYNAMO-ELECTRIC MACHINES.—Since the date of the author's former paper in April, 1879, other observers have published the results of experiments similar to those described by him. It may be well to exhibit some of these results reduced to the form he has adopted, viz., a curve, such as that shown in Fig. 4, *Proceedings*, 1879, Plate 29, and now reproduced, with slight alterations, in Fig. 1. Here any abscissa represents a current passing through the dynamo-electric machine,

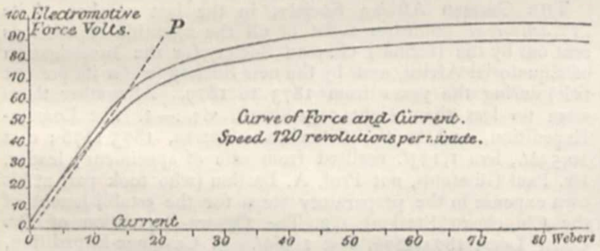


FIG. 1.

and the corresponding ordinate represents the electromotive force of the machine for a certain speed of revolution, when that current is passing through it. It will be found (1) that with varying speed the ordinate or electromotive force, corresponding to any abscissa or current, is proportional to the speed; (2) that the electromotive force does not increase indefinitely with increasing current, but that the curve approaches an asymptote; (3) that the earlier part of the curve is, roughly speaking, a straight line, until the current attains a certain value, and that at that point the electromotive force has reached about two-thirds of its maximum value. When the current is such that the electromotive force is not more than two-thirds of its maximum, a very small change in the resistance with speed of engine constant, or in the speed of the engine with resistance constant, causes a great change in the current. For this reason such a current, which is the same for all speeds of revolution, since the curves for different speeds differ only in the scale of ordinates, may be called the "critical current" of the machine. The effect of a change of speed is exhibited in Fig. 1, where the lower line represents a curve for a speed of 660 revolutions per minute, instead of 720. The resistance, varying as $\frac{\text{electromotive force}}{\text{current}}$, is given by the slope of the line O P, which must therefore be constant; and it will be seen that this line cuts the upper curve at a point corresponding to a current of 15 webers, and the lower at a point corresponding to a current of 5 webers only.

In Germany, Auerbach and Meyer (*Wiedemann's Annalen*, November, 1879) have experimented fully on a Gramme machine at various speeds, and with various external resistances. The resistance of the machine was 0·97 ohms. Their results are summarised in a table at the end of their paper, which gives the current passing, with resistances in circuit from 1·75 to 200 Siemens units, and at speeds from 20 to 800 revolutions per minute. In the accompanying diagram, Fig. 2, curve No. 1, expresses the relation between electromotive force and current, as deduced from some of their observations, making allowance, where necessary, for difference in speed. The curve, as actually constructed, is for a speed of 800 revolutions: at this speed it will be seen that the maximum electromotive force is about 76 volts; the critical current, corresponding to a force of about 51 volts, is 6·5 webers, with a total resistance of 7·8 ohms. Up to this point there will be great instability, exactly as was the case in the Siemens machine examined by the author, where the resistance was 4 ohms, and the speed 720 revolutions.

[1] Paper read at the Institution of Mechanical Engineers, by Dr. John Hopkinson, F.R.S.

The results of an elaborate series of experiments on certain dynamo-electric machines have recently been presented to the Royal Society by Dr. Siemens. One of the machines examined was an ordinary medium-sized machine, substantially similar to that tried by the author in 1879. It is described as having 24 divisions of the commutator; 336 coils on the armature, with a resistance of 0·4014 Siemens units; and 512 coils on the magnets, with a resistance of 0·3065; making a total resistance of

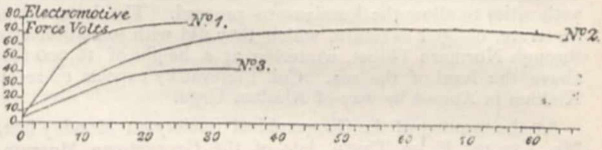


FIG. 2.

0·7079 Siemens units = 0·6654 ohms. Curve No. 2 gives the relation of electromotive force and current, reduced to a speed of 700 revolutions per minute, the actual speeds ranging from 450 to 800 revolutions. The maximum electromotive force appears to be probably 76 volts, and the critical current 15 webers, which is the same as in the author's first experiments on a similar machine.

In the summer of last year the author examined a Siemens machine of the smallest size. This machine is generally sold as an exciter for their alternate current machine. It has an internal resistance of 0·74 ohms, of which 0·395 is in the armature or helix. The machine is marked to run at 1,130 revolutions per minute. The following Table gives, for a speed of 1,000 revolutions, the total resistance, current, electromotive force, and horse-power developed as current. The horse-power expended was not determined:—

Experiments on smallest-sized Siemens Dynamo-Electric Machine

Resistance. Ohms.	Electric current. Webers.	Electromotive force. Volts.	Horse-power developed as current. H. P.
2·634	4·53	13·2	0·08
2·221	10.8	27·0	0·39
1·967	15·1	33·6	0·68
1·784	18·1	36·4	0·88
1·668	19·8	37·2	0·98
1·579	20·6	36·6	1·01
1·503	22·8	39·3	1·20
1·440	24·7	40·0	1·32
1·145	32·2	41·5	1·79

Curve No. 3 gives as usual the relations of electromotive force and current. From this curve it will be seen that the critical current is 11·2 webers, and the maximum electromotive force, at the speed of 1,000 revolutions, is about 42 volts. The determinations for this machine were made in exactly the same manner as in the experiments on the medium-sized machine, using the galvanometer, but omitting the experiment with the calorimeter (compare Table I., p. 249, *Proceedings*, April, 1879).

The time required to develop the current in a Gramme machine has been examined by Herwig (Wiedemann, June, 1879). He established the following facts for the machine he examined. A reversed current, having an electromotive force of 0·9 Grove cells, sufficed to destroy the residual magnetism of the electro-magnets. If the residual magnetism was as far as possible reduced, it took a much longer time to get up the current than when the machine was in its usual state. A longer time was required to get up the current when the external resistance was great, than when it was small. With ordinary resistance the current required from ¾ second to 1 second to attain its maximum.

Brightness of the Electric Arc.—The measurement of the light emitted by an electric arc presents certain peculiar difficulties. The light itself is of a different colour from that of a standard candle, in terms of which it is usual to express luminous intensities. The statement, without qualification, that a certain electric lamp and machine give a light of a specified number of candles, is therefore wanting in definite meaning. A red light cannot with propriety be said to be any particular multiple of a green light; nor can one light, which is a mixture of colours, be said with strictness to be a multiple of another, unless the proportions of the colours in the two cases are the same. Capt. Abney (*Proceedings* of the Royal Society, March, 1878) has given the results of measurements of the red, blue, and actinic light of electric arcs, in terms of the red, blue, and actinic light of a standard candle. The fact that the electric light is a very different mixture of rays from the light of gas or of a candle, has long been known, but has been ignored in statements intended for practical purposes.

Again, the emission of rays from the heated carbons and arc is by no means the same in all directions. Determinations have been made in Paris of the intensity in different directions, in particular cases. If the measurement is made in a horizontal

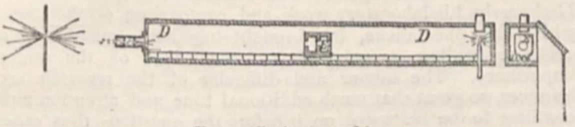


FIG. 3 (Scale about $\frac{1}{16}$).

direction, a very small obliquity in the crater of the positive carbon will throw the light much more on one side than on the other, causing great discordance in the results obtained.

If the electric light be compared directly with a standard candle, a dark chamber of great length is needed—a convenience not always attainable. In the experiments made at the South Foreland by Dr. Tyndall and Mr. Douglass, an intermediate standard was employed; the electric light was measured in terms of a large oil lamp, and this latter was frequently compared with a standard candle.

Other engagements have prevented the author from fairly attacking these difficulties; but since May 1879 he has had in occasional use a photometer with which powerful lights can be measured in moderate space. This photometer is shown in Fig. 3, and an enlargement of the field-piece in Fig. 4. A lens

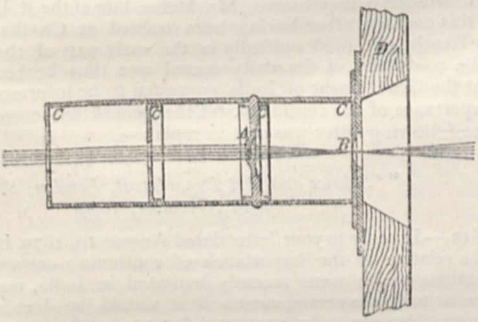


FIG. 4 (Scale about $\frac{1}{2}$).

A, of short focus, forms an image at B of the powerful source of light which it is desired to examine. The intensity of the light from this image will be less than that of the actual source by a calculable amount; and when the distance of the lens from the light is suitable, the reduction is such that the reduced light becomes comparable with a candle or a carcel lamp. Diaphragms CC are arranged in the cell which contains the lens, to cut off stray light. One of these is placed at the focus of the lens, and has a small aperture. It is easy to see that this diaphragm will cut off all light entering from a direction other than that of the source; so effectually does it do so, that observations may be made in broad daylight on any source of light, if a dark screen be placed behind it. The long box DD, Fig. 3, of about 7 feet length, is lined with velvet—the old-fashioned dull velvet—not that now sold with a finish, which reflects a great deal of the light incident at a certain angle. This box serves as a dark chamber, in which the intensity of the image formed by the lens is compared with a standard light, by means of an ordinary Bunsen's photometer E, sliding on a graduated bar.

Mr. Dallmeyer kindly had the lens made for the author: he can therefore rely upon the accuracy of its curvature and thickness; it is plano-convex, the convex side being towards the source of light. The curvature is exactly 1 inch radius, and the thickness is 0·04 inch; it is made of Chance's hard crown glass, of which the refractive index for the D line in the spectrum is 1·517. The focal length f is therefore 1·933 inch.

Let u denote the distance of the source of light from the curved surface of the lens, and v the distance of the image of the source B from the posterior focal plane. Neglecting for the moment loss by reflection at the surface of the glass, the intensity of the source is reduced by the factor $\left(\frac{v}{u}\right)^2$. But $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$, or $v = \frac{uf}{u - f}$; hence the factor of reduction is $\left(\frac{f}{u - f}\right)^2$. The effect of absorption in so small a thickness of very pure glass may be neglected; but the reflection at the surfaces will cause a loss of 8·3 per cent. which must be allowed for. This percentage is calculated from Fresnel's formulæ, which are certainly accurate for glasses of moderate refrangibility, and for moderate angles of incidence.

Suppose, for example, it is required to measure a light of 8,000 candles; if it be placed at a distance of 40 inches it will be reduced in the ratio 467 to 1, and becomes a conveniently measurable quantity. By transmitting through coloured glasses both the light from an electric lamp and that from the standard, a rough comparison may be made of the red or green in the electric light with the red or green in the standard.

A dispersive photometer, in which a lens is used in a somewhat similar manner, is described in Stevenson's "Lighthouse Illumination." Messrs. Ayrton and Perry described a dispersive photometer with a concave lens at the meeting of the Physical Society on December 13, 1879 (*Proc.* of the Physical Society, vol. iii. p. 184). The convex lens possesses however an obvious advantage in having a real focus, at which a diaphragm to cut off stray light may be placed.

Efficiency of the Electric Arc.—To define the electrical condition of an electric arc, two quantities must be stated: the current passing, and the difference of electric potential at the ends of the two carbons. Instead of either one of these, we may, if we please, state the ratio $\frac{\text{difference of potential}}{\text{current}}$, and call it the resistance of the arc, that is to say, the resistance

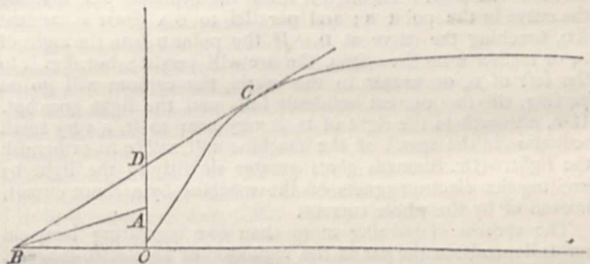


FIG. 5.

which would replace the arc without changing the current. But such a use of the term electric resistance is unscientific; for Ohm's law, on which the definition of electric resistance rests, is quite untrue of the electric arc; and, on the other hand, for a given material of the electrodes, a given distance between them, and a given atmospheric pressure, the difference of potential on the two sides of the arc is approximately constant. The product of the difference of potential and the current is of course equal to the work developed in the arc; and this, divided by the work expended in driving the machine, may be considered as the efficiency of the whole combination. It is a very easy matter to measure these quantities. The difference of potential on the two sides of the arc may be measured by the method given by the author in his previous paper, by an electrometer, or in other ways. The current may be measured by an Obach's galvanometer, by a suitable electro-dynamometer, or best of all, in the author's opinion, by passing the whole current, on its way to the arc, through a very small known resistance, which may be regarded as a shunt for a galvanometer of very high resistance, or to the circuit of which a very high resistance has been added.

It appears that with the ordinary carbons and at ordinary atmospheric pressure no arc can exist with a less difference of potential than about 20 volts; and that in ordinary work, with an arc about $\frac{1}{4}$ inch long, the difference of potential is from 30 to 50 volts. Assuming the former result, about 20 volts, for the difference of potential, the use of the curve of electromotive forces may be illustrated by determining the lowest speed at which a given machine can run, and yet be capable of producing a short arc. Taking O as the origin of co-ordinates, Fig. 5, set off upon the axis of ordinates the distance OA equal to 20 volts; draw AB to intersect at B the negative prolongation of the axis of abscissæ, so that the ratio $\frac{OA}{OB}$ may represent the necessary metallic resistance of the circuit. Through the point B, thus obtained, draw a tangent to the curve, touching it at C, and cutting O A in D. Then the speed of the machine, corresponding to the particular curve employed, must be diminished in the ratio $\frac{OD}{OA}$, in order that an exceedingly small arc may be just possible.

The curve may also be employed to put into a somewhat different form the explanation given by Dr. Siemens at the Royal Society respecting the occasional instability of the electric light as produced by ordinary dynamo-electric machines. The operation of all ordinary regulators is to part the carbons when the current is greater than a certain amount, and to close them when it is less; initially the carbons are in contact. Through the origin O, Fig. 6, draw the straight line O A, inclined at the angle

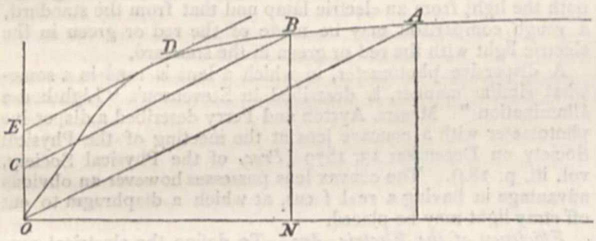


FIG. 6.

representing the resistances of the circuit other than the arc, and meeting the curve at A. The abscissa of the point A represents the current which will pass if the lamp be prevented from operating. Let O N represent the current to which the lamp is adjusted; then if the abscissa of A be greater than O N, the carbons will part. Through N draw the ordinate B N, meeting the curve in the point B; and parallel to O A draw a tangent E D, touching the curve at D. If the point B is to the right of D, or farther from the origin, the arc will persist; but if B is to the left of D, or nearer to the origin, the carbons will go on parting, till the current suddenly fails and the light goes out. If B, although to the right of D, is very near to it, a very small reduction in the speed of the machine will suffice to extinguish the light. Dr. Siemens gives greater stability to the light by exciting the electromagnets of the machine by a shunt circuit, instead of by the whole current.

The success of burning more than one regulating lamp in series depends on the use in the regulator of an electro-magnet, excited by a high-resistance wire connecting the two opposed carbons. The force of this magnet will depend upon the difference of potential in the arc, instead of depending, as in the ordinary lamp, upon the current passing. Such a shunt magnet has been employed in a variety of ways. The author has arranged it as an attachment to an ordinary regulator; the shunt magnet actuates a key, which short-circuits the magnet of the lamp when the carbons are too far parted, and so causes them to close.

In conclusion the author ventures to remind engineers of the following rule for determining the efficiency of any system of electric lighting in which the electric arc is used, the arc being neither exceptionally long nor exceptionally short. Measure the difference of potential of the arc, and also the current passing through it, in volts and webers respectively; then the product of these quantities, divided by 746, is the horse-power developed in that arc. It is then known that the difference between the horse-power developed in the arc and the horse-power expended to drive the machine must be absolutely wasted, and has been expended in heating either the iron of the machine or the copper conducting wires.

PRELIMINARY REPORT BY THE COMMITTEE ON SOLAR PHYSICS APPOINTED BY THE LORDS OF THE COMMITTEE OF COUNCIL ON EDUCATION

"SIR,—In reply to Mr. MacLeod's letter of November 20, 1879, calling upon us, pending the preparation of our General Report, to give a brief summary of the progress already made, and to state at the same time what work was in hand, and such other facts as we might think it desirable to mention, to enable their Lordships to determine whether they shall apply to the Lords Commissioners of Her Majesty's Treasury for an extension of the vote for another year, we have the honour now to submit the following report.

"The Committee have had thirteen formal meetings. In addition to this several members of the Committee have carried out special branches of the inquiry; and Mr. Lockyer, as arranged when the Committee was appointed, has been charged with the general conduct of the observational and experimental work at South Kensington. The Committee consider that Mr. Lockyer by his laboratory work and comparison of the results with solar phenomena, has brought together a great body of evidence tending *primâ facie* to conclusions of the utmost importance. The labour and difficulty of the research are, however, so great that much additional time and attention must continue to be bestowed on it before the questions thus raised can be considered as finally settled; and the Committee think it of much importance that the researches now being carried on should not be interrupted.

"The Committee have been in correspondence with the Indian Government, the Astronomer-Royal, the Directors of the Observatories at Wilna, Melbourne, Mauritius, Kew, Moscow, Toronto, Paris, Palermo, Princeton, and with Dr. Warren De la Rue. From all of these promises of valuable co-operation and assistance have been received. To the Astronomer-Royal our thanks are specially due for the manner in which he has met us in the matter, placing all the information bearing on the subject in the Royal Observatory at our service.

"A few months before the appointment of the Committee, daily photographs of the sun had been commenced by order of the Government of India under the Surveyor-General at Dehra, N.W. Provinces, the photographs being transmitted to Mr. Lockyer for reduction.

"Unfortunately the observer, Mr. Meins, late of the R.E., sent from this country, after having been trained at Chatham and South Kensington, died suddenly in the early part of the year, and the continuity of the daily record was thus broken. In August the Government of India requested to be informed as to the importance of the continuance of the records thus interrupted, and the following letter was sent in reply:—

"'*Science and Art Department, London, S.W.*,
"'*27th November*, 1879

"'SIR,—In reply to your letter dated August 10, 1879, inviting remarks relative to the importance of continuing certain solar observations which were recently instituted in India, and suggestions as to future arrangements if it should be decided that the observations are to be continued for an indefinite period, I beg leave to submit to you, for the information of Lord Cranbrook, the following explanation:—

"'In their General Report the Science Commissioners recommended the establishment of a system of physical (as distinguished from astronomical) observations on the sun, and pointed out the advantages which Northern India offers for this study. A memorial was more recently presented to Government, signed by a number of our leading scientific men, urging the carrying out of this recommendation.

"'In compliance with these recommendations the British Government as a preliminary step appointed a Committee on Solar Physics, whose duty it should be to make trial of methods of observation, collect observed results, &c., and who were specially charged with the reduction of such observations as should be made in India. As a consequence of this arrangement the Government of India authorised the employment of the late Mr. Meins for the purpose of taking photographs of the sun in India, and a series of such photographs was prepared by him and has been sent home to be dealt with. The following brief statement will show how superior the climate of India is to our own for observations of this kind. The Astronomer-Royal has been so kind as to furnish the Committee with a list of the solar photographs taken at the Royal Observatory during the period 21st July, 1873, to 18th July, 1879, over a part of which Mr. Meins' work extended. It should be mentioned that in both places alike the rule was to take three photographs daily, in the morning, about noon, in the afternoon, when clear views of the sun could be obtained. In the rare cases in which a fourth photograph was taken in the same day in India, it is not included in the following list:—

	Greenwich.	India.
Total number of days during which both instruments were working simultaneously between February 11th, 1878, and March 31st, 1879	384	
Total number of photographs. Reducing where four or more have been taken to three	207	872
Number of days on which one at least was taken	143	342
Number of days on which no photograph was taken	244	42

"'No correction has been made for the non-taking of photographs at Greenwich on Sundays.

"'In the total number of photographs the maximum number taken on any one day has been taken as three.

"'The actual returns are inclosed as an appendix B and C.[1]

"'It so happens that for the last year or two the sun has been in a condition of unusual quiescence, so that in the whole series of photographs sent home by Mr. Meins there were only two or three small spots. But it is well established by previous experience that the sun passes alternately through a condition of few spots and many spots, the whole period of the change being about eleven years. We are now, according to the reckoning, entering on a period of solar activity, and already spots have begun to appear. The present time and the immediate future form therefore a period of special interest for the observation of solar phenomena. And though the immediate object of the memorialists in advocating a more active study of solar physics was an increase to our scientific knowledge, it is hard to say what bearings such an increase may not have upon the practical concerns of life. There is some reason to think that meteorological conditions bear traces of a period similar to that of solar activity as manifested by spots, and it has been conjectured that the droughts and consequent famines which from time to time have devastated portions of our Indian Empire show something of a similar period. Should a further study of solar phenomena lead to even an approximate forecast of the liability to such terrible visitations, it is needless to say of what practical importance it would thereby become.

"'As has been already explained the Committee were appointed as a temporary measure to prepare the way for something of a more permanent and systematic nature, and it is to aid them in this work that the Indian observations have been asked for. What shape the research may permanently take it is impossible at the present time to predict.

"'In view of these facts the Committee is of opinion that it is of special importance that the series of Indian sun photographs should be resumed as early as practicable, if, as is feared, they have been interrupted, and should be continued without break at all events for three or four years to come, the present period of increasing solar activity being one of peculiar scientific interest.

"'The Committee further suggest that the Surveyor-General of India, under whom Sergeant White, the successor of Mr. Meins, will be employed, might usefully be instructed to cause one or more native *employés* of the Survey Department to be instructed in the process of solar photography, so that risk of interruption of the series from sickness, &c., of the European photographer may be guarded against in the future.

"'It is believed that skill in the necessary manipulations for successful photography could be readily acquired by intelligent natives, and that when this had been done further assistance from this country for the supply of photographers would not be needed.

"'I have the honour to be, Sir,

"'Your obedient servant,

"'(Signed) "'G. G. STOKES'

"Considerations in all respects identical with those which we thought of weight in regard to India are in our opinion generally applicable, and we have no hesitation in expressing our belief that the continued careful study of the class of phenomena in question will prove to be of the greatest scientific value, and that there is no reason for doubting that the advance of true knowledge in this direction will, in some form or other, and sooner or later, prove to be of real practical value also, as all experience has shown that it has been in other branches of human knowledge.

[1] It has not been considered necessary to reproduce these appendices in this place.

"Whether or not we shall ever possess the power of foreseeing the character of the seasons in this country, or to what extent they may in truth be related to those changes in the condition of the sun to which our attention is specially directed, it is of course impossible for us to say. But of the extreme importance of doing all that lies in our power to advance a sound knowledge of the laws of climate which so directly affect the well-being of the whole human race there can be no question.

"We append details of the work in which we have been engaged.

"G. G. STOKES
BALFOUR STEWART
RICHARD STRACHEY
J. NORMAN LOCKYER
W. DE W. ABNEY
J. F. D. DONNELLY

"The Secretary, Science and Art Department"

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—It appears rather noteworthy that at a very recent debate in the Cambridge Union (May 4), a motion proposed by Mr. Theodore Beck, of Trinity College, affirming that the Tripos system of education here adopted is unfavourable to the interests of original research and individual culture, should have been lost by only three votes, after speeches in opposition to the motion in which more than one distinguished Tripos man took part. The votes were: For the motion, 51; against, 54.

Mr. E. Temperley, of Queen's College, and Mr. W. Burnside, of Pembroke College (on the nomination of Corpus Christi College), have been appointed Moderators for the next Mathematical Tripos.

It appears from the discussion on the subject of the exemption from Greek of honours students who desire exemption, and offer French and German, that there is much diversity of opinion on the subject, even among residents. How long will it be before the ideas of freedom have practical effect in Cambridge? Dr. Thompson, Master of Trinity, was strongly desirous that Greek should not be required of men coming to Cambridge as serious students of mathematics and natural science. He had no wish to weaken the position of Greek, but to allow men to come to the University and obtain distinction in their own line. Prof. Skeat wondered why a knowledge of English language and literature could not yet find a place in the course for the Little-go; the University had very few studying or capable of teaching it in a scientific way. Mr. Henry Jackson said the present system put many boys through the drudgery of learning the rudiments to get the chance of making classical scholars of a few. Mr. Vansittart gave expression to the regret of many that it should be proposed to substitute two languages for Greek; he would give as alternatives natural sciences for mathematical men, and additional mathematics for natural science men, or he would leave the choice between English and natural sciences.

It is to be hoped that Cambridge University will cease from the fruitless attempt to find out one universal mode of culture and routine for schools. The Local Examinations Syndicate have already done this, not having to secure the approbation of the entire Senate for all the alternative subjects it offers. But the Public Schools follow too much the lead of the Pass Examinations in the Universities. The Syndicate, considering the question, have referred very much to the opinions of head-masters of public schools, and because they feel so much that their "craft" is in danger, the great need of gaining the mass who do not go to public schools may be lost sight of.

THE late Mr. John Henry Challis bequeathed 100,000*l.* to the University of Sydney. Its Parliamentary assistance is only 5,000*l.* per annum, a sum quite insufficient to secure as many Chairs in the different faculties as the name of University implies. The bequest of Mr. Challis, invested at 5 per cent., will add another 5,000*l.* per annum to the sum voted by Parliament, and will enable the faculties to enlarge their curriculum and extend their operations in a manner they have never yet had the means to attempt.

SCIENTIFIC SERIALS

American Journal of Science, April.—Berthelot's thermochemistry, by J. P. Cooke.—History of the pre-cambrian rocks in America and Europe, by T. Sterry Hunt.—Synopsis of the cephalopoda of the north-eastern coast of America, by A. E. Verrill.—Notices of recent American earthquakes, by C. J. Rockwood, jun.—Observations on the height of land and sea-breezes, taken at Coney Island, by O. T. Sherman.—New method of spectrum observation, by J. N. Lockyer.—Presentation of sonorous vibrations by means of a revolving lantern, by H. Carmichael.—Chemical composition of childrenite, by J. L. Penfield.—Observations on the planet Lilæa, by C. H. F. Peters.—Efficiency of Edison's electric light, by H. A. Rowland and G. F. Barker.

Annalen der Physik und Chemie, No. 3.—On the behaviour of carbonic acid in relation to pressure, volume, and temperature, by R. Clausius.—On a relation between pressure, temperature, and density of saturated vapours of water and some other liquids (continued), by A. Winkelmann.—Researches on the vibrations of a normal tuning-fork, by R. Koenig.—Researches on the equipotential distribution of the magnetic fluids of cylindrical steel bars, by W. Schaper.—General theory of the deadening influence of a multiplier on a magnet (continued), by K. Schering.—On ultra-violet rays, by J. L. Schönn.—On a spectrotelescope, by P. Glan.—On a new simple mode of streak observation, by V. Dvorak.—Contribution to a history of the mechanical theory of heat, by E. Oedler.

Journal de Physique, April.—On the measurement of wave-lengths of infra-red radiations, by M. Mouton.—Solar spots and protuberances observed with a spectroscope having great dispersion, by M. Thollon.—Measurement of the electromotive force of contact of metals by the Peltier phenomenon, by M. Pellat.—Description and use of the telescope and scale of Edelmann, by M. Terquem.

Journal of the Franklin Institute, April.—Naval architecture, by Mr. Haswell.—Saws, by Dr. Grimshaw.—Engraving, by Mr. Sartain.—On D'Auria's engine-governor and the action of governors in general, by Prof. D'Auria.—A new hypothesis regarding comets and temporary stars, by Prof. Tobin.

Rivista Scientifico-Industriale, No. 6, March 31.—On a case of permanent polarity of steel opposite to that of the magnetising helix which produces it, by Prof. Righi.—Reflexions on an experimental and fundamental principle in hydrostatics, by Prof. Cantoni.—On Elban topaz, by S. Corsi.

No. 7, April 15.—Radiant matter and the theory of Crookes, by S. Piazzoli.—Pliocene fossils of the yellow sand found in the neighbourhood of Vigne, Schifanoia, and Montoro (Narni), with a suggestion as to the subapennine formation of these three places, by S. Terrenzi.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. xiii. fasc. iii.—On Garovaglineæ, a new tribe of Collemaceæ, by S. Trevisan.—Comparison of the winter 1879-80 with the preceding one in Milan, by Prof. Hajech.—Diurnal oscillations of the declination-needle, in 1879, at the Brera Observatory, Milan, by Prof. Schiaparelli.—Transfusion of blood into the peritoneum in an oligocitemic lunatic; effects on the circulation of blood and on the general state of the patient, by Profs. Golgi and Raggi.—The nephodoscope, an instrument for determining the direction of motion of clouds, by Prof. Fomiori.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 22.—"On the Critical State of Gases." By William Ramsay, Ph.D., Professor of Chemistry in University College, Bristol.

It is well known that at temperatures above that which produces what is termed by Dr. Andrews the "critical point" of a liquid, the substance is supposed to exist in a peculiar condition, and Dr. Andrews purposely abstained from speculating on the nature of the matter, whether it be liquid or gaseous, or in an intermediate condition, to which no name has been given. As my observations bear directly on this point, it may be advisable first to describe the experiments I have made, and then to draw the deductions which appear to follow from them.

A piece of barometer tubing about three inches long was sealed at one end and drawn into a capillary tube at the other; after being filled with methyl formate it was exhausted, and after two-thirds of the ether had evaporated was sealed. By this means all air was removed from the tube, which contained merely the ether and its vapour.

1. On applying heat the temperature gradually rose to 221°·5 (corr.); during the rise the meniscus of the liquid gradually became less curved, and at the above-mentioned temperature disappeared. On cooling to 218° a mist was seen at the point where the meniscus had disappeared, and the meniscus shortly afterwards became again visible.

2. Two similar tubes were prepared, one containing less and the other more of the same ether; the point at which the meniscus disappeared in the former was 228°, and in the latter 215°.

3. A tube of the shape shown was filled to the mark with methyl formate and heated in an inclined position, the portion containing the liquid being the lower. The liquid, as usual, expanded, and at the moment when the meniscus disappeared it nearly filled the lower half. The source of heat was then withdrawn, and on cooling the liquid all condensed in the *lower* half.

4. The last experiment was varied by tilting the tube after the meniscus of the liquid had disappeared, so that that half which had contained the liquid was uppermost. On cooling, the liquid condensed in the *upper* half of the tube.

5. The experiment was again varied by keeping the tube at a temperature a few degrees above the point where the meniscus vanished, for half an hour. On cooling, an almost equal quantity had condensed in each division of the tube. (During Experiments 3, 4, and 5, great care must be taken to keep the heater from draughts of cold air, otherwise unequal cooling results and distillation takes place.)

6. It was noticed that that half of the tube containing liquid, after the meniscus had vanished, appeared *full*, while the other half of the tube seemed to be *empty*. The refractive indices of the fluid contained in the tubes were therefore different. The portion of the tube containing liquid was shown to be a more powerful cylindrical lens than the empty portion, for on focussing a spot behind the tube with a microscope, the focus was shorter when the portion which had contained liquid was placed between the microscope and the spot than when the portion appearing empty was interposed.

7. From experiments on the expansion of liquids above their boiling-points, of which numerical details shall be given on a future occasion, it appears probable that the specific gravity of the hot liquid, at the temperature at which the meniscus vanishes, is identical with that of the compressed gas evolved from the liquid. This has also been noticed by Ansdell in two cases, viz., hydrogen chloride and acetylene.

8. From observations on the expansions of liquids at high temperatures it has been proved that liquids above the temperatures at which their menisci vanish are not uniformly compressible.

From these observations I would draw the following inferences:—When a liquid is heated under pressure it expands, and at the same time evolves vapour. The vapour gains in specific gravity, while the specific gravity of the liquid is rapidly diminishing. *The critical point is that point at which the liquid, owing to expansion, and the gas, owing to compression, acquire the same specific gravity, and consequently mix with one another.* From the first experiment it is seen that, on cooling, the liquid contracts more rapidly than the gas, and consequently separates as a mist through the whole of the tube, and, from its gravity, separates at the lower half. The second experiment shows that when the tube contains a small amount of liquid the space left for gas is larger, and consequently more vapour must be given off by the liquid before enough gas can be compressed till it acquires the same specific gravity as the liquid; the temperature at which the meniscus disappears is consequently higher. If the space left for gas be smaller, the opposite is the case. The fourth, fifth, sixth, and seventh experiments demonstrate that by suitable means it is possible to prevent, or rather to retard, the mixing of gas and liquid. They then retain their several refractive indices. If, however, time be allowed for diffusion through the capillary tube, the whole becomes homogeneous, and the refractive indices of the fluids contained in either portion of the tube are then identical.

So long as gas is being compressed, pressure rises gradually with decrease of volume, whereas, even above their critical points, liquids are comparatively incompressible.

In conclusion, let me refer to a paper communicated to the Society by Messrs. Hannay and Hogarth last October, entitled "On the Solubility of Solids in Gases." Should the views of the subject suggested by the above experiments be correct, it follows that these gentlemen have observed nothing unusual, but merely the ordinary phenomenon of solubility of a solid in a hot liquid. This view is borne out by their own experiments. They found that on reducing pressure, that is, on allowing the liquid to change to gas, the solid precipitated; and also on heating the tube containing the solution locally, that is, by converting the liquid near the heated point into gas, precipitation took place. I have taken the liberty of repeating one of their experiments with a slight modification.

A tube shaped like that used in Experiment 3, after a small fragment of potassium iodide had been placed in the lower compartment, was filled with nearly anhydrous alcohol; and after rather more than two-thirds of the alcohol had been evaporated under reduced pressure, the tube was sealed. The lower portion of the tube contained a strong alcoholic solution of potassium iodide, besides a small piece of undissolved salt. The upper portion of the tube was free from alcohol, but its walls were incrusted with a thin crystalline film of potassium iodide. The tube was heated in a sloping position, the liquid being in the lower half. After the meniscus had disappeared, the iodide in the lower half of the tube dissolved, while the film in the upper half, even in its thinnest portions, remained unchanged. On cooling, very sparkling crystals deposited in the lower half of the tube, but no glittering crystals in the upper half.

By repeated distillation the iodide in the upper portion of the tube was washed down into the lower half, and when dry the sides of the upper tube were quite bright and clean. The tube was again heated in the same position to 20° above the temperature at which the meniscus had disappeared. On cooling, the sparkling crystals again appeared in the lower tube, but not a trace in the upper tube. To eliminate all possibility of mistake the experiment was repeated five times with the same result, and finally the alcohol was distilled into the upper tube; it was then broken off, and its contents carefully tested for iodine with sodium hypochlorite and starch-paste. There was not the faintest blue colour, and it is therefore certain that potassium iodide is absolutely insoluble in alcohol vapour.

Messrs. Hannay and Hogarth also found that the absorption spectrum of coloured salts remains unaltered, even when the liquid in which they are dissolved loses its meniscus. Surely no clearer proof is needed to show that the solids are not present as gases, but are simply solutions in a liquid medium.

To eliminate any source of error dependent on the use of methyl formate, two other substances were employed, viz., carbon disulphide, CS_2, and carbon tetrachloride, CCl_4. The former of these liquids was rectified five times over sodium, and then boiled at 48·7 (corr.). The latter was rectified four times over phosphoric anhydride, and boiled constantly at 77·5 (corr.). They yielded the following results:—

	Tube more than half full.	Tube less than half full.
CS_2	282·7	286·4
CCl_4	283·3	288·4

These readings are given for the first appearance of a cloud in the tube on cooling, and differ from the temperature at which the meniscus disappears by being about half a degree lower. They also do not represent extreme instances, for in the first cases the liquids do not entirely fill the tube, and in the second about half an inch of liquids remains in the tubes before it becomes impossible to distinguish liquid from gas.

The experiments described in a former part of this paper, relating to the difference of refraction shown by a liquid above its so-called critical point, and the gas evolved from it, were repeated with carbon tetrachloride and carbon disulphide, and held good in both cases. The phenomena observed differed in no particular from those already described.

In conclusion, a few remarks on the liquefaction of the so-called permanent gases may not be deemed out of place. If the deductions from the above experiments be correct, it follows that that form of matter which we call gas may be converted into liquid by pressure alone; but the meniscus will never become visible, for the process of change is a gradual one. To render the meniscus visible it is necessary to take advantage of the fact that liquids under such circumstances have a much greater coefficient of expansion by heat, and conversely, a much greater coefficient of contraction on withdrawal of heat, than gases. It therefore becomes necessary to lower the temperature until the liquid by contraction acquires a specific gravity greater than that of its gas, and then, and not till then, does the phenomenon of a meniscus become observable.

April 29.—"On the Diurnal Variation in the Amount of Carbon Dioxide in the Air." By George Frederick Armstrong, M.A., F.G.S., C.E., Professor of Engineering in the Yorkshire College, Leeds. Communicated by Prof. Thorpe, F.R.S.

Summarising the results contained in this communication, it may be stated—

1. That the normal amount of carbonic acid present in the air of the land is distinctly less than that usually stated, and that it does not exceed 3·5 vols. in 10,000 of air.

2. That plants absorb carbonic acid during the day and exhale it at night, and that vegetation therefore affects the quantity of carbonic acid present in the air, decreasing it by day and increasing it at night.

3. That from this cause there is, during that part of the year when vegetation is active, at least 10 per cent. more carbonic acid present in the air of the open country at night than during the day.

Chemical Society, May 6.—H. E. Roscoe, president, in the chair.—The following papers were read:—On the action of sodium on phenylic acetate, by W. H. Perkin, jun., and W. Hodgkinson. Hydrogen, acetic ether, phenol, acetic acid, salicylic acid, a white crystalline substance melting at 48° C., having the composition $C_{15}H_{12}O_3$, and a yellow crystalline substance melting at 138°, having the composition $C_{18}H_{14}O_4$, were obtained; by heating cresylic acetate and sodium, acetic ether and salicylic acid were formed.—Preliminary notice on the action of sodium on some ethereal salts of phenylacetic acid, by Dr. Hodgkinson. The first products of this action are the corresponding ethylic, &c., ethers of phenylacetic acid. The phenyl group being replaced by hydrogen, it reacts with sodium on another portion of the original ethereal salt, forming various liquid and solid bodies, which the author has investigated, but whose constitution is as yet undetermined.—On the determination of nitrogen in carbon compounds, by C. E. Groves. The author described and exhibited an improved and simple apparatus for facilitating the collection and measurement of the nitrogen evolved during the combustion of a substance according to Dumas' method.—On essential oil of sage, by M. M. P. Muir. The composition of this oil varies with its age, salviol and camphor being formed as it gets older. English sage-oil contains cedrene. The terpene of sage-oil is identical with that of French turpentine. The author has examined the action of oxidising agents, phosphorous pentachloride, and bromine.—On the presence of nitrogen in iron and steel, by A. H. Allen. By passing steam over iron at a red-heat, and also by dissolving iron in hydrochloric acid, the author has satisfactorily proved that ammonia is formed equal to 0·0041 to 0·0172 parts of nitrogen per hundred parts of iron and steel.—On the mode of application of Pettenkofer's process for the determination of carbonic acid in expired air, by Dr. W. Marcet. The author describes and figures a portable apparatus which he has successfully used in upwards of 350 determinations of carbonic acid made during some investigations on the effect of altitude on the phenomena of respiration.—On an improved form of oven for heating sealed tubes and avoiding risks of explosions, by Watson Smith.—Note on a convenient form of lead-bath for Victor Meyer's apparatus for determining the vapour-densities of high boiling substances, by Watson Smith.

Anthropological Institute, April 27.—Major-General A. Pitt-Rivers, F.R.S., vice-president, in the chair.—Edward Tyrrell Leith, LL.M., was elected a new member.—A paper entitled "Further Notes on the Romano-British Cemetery at Seaford, Sussex," by Mr. F. G. Hilton Price and Mr. John E. Price was read. It was a continuation of one read before the Institute by the same authors in November, 1876. During the summer of 1879 these gentlemen again visited Seaford, and made further excavations in the Roman Cemetery upon the Downs, in which they discovered several urns, a drinking cup of Durobrivian pottery, Samian pateræ, flint celts of the neolithic type, and many flint flakes. In one particular interment a large urn full of charred human bones was discovered, having a Samian cup in its mouth for the purpose of keeping out the earth, another cup of elegant form of Durobrivian ware was found on its left side, and a food vessel and patera of Upchurch pottery on the right side. In close proximity to this interment was a similar one; the urn was much crushed, but beneath a patera of Samian ware a coin of Faustina Junior, the daughter of Antoninus Pius and wife of Marcus Aurelius, was found. This was most important as giving an approximate date to the interments; they could not be earlier than between A.D. 161-180. In another part of the Downs, in a place called the Little Burys, black patches were of frequent occurrence in the sand, which were composed of charcoal, fragments of burnt bone, a flint flake or two, and frequently iron nails. In one particular spot a batch of over ninety iron studs was found, mixed up with bone ashes and charcoal. The authors considered that the patches of charcoal without an urn indicated pauper burials, or the burials of soldiers, as this place was a military station. The pottery and other relics discovered were exhibited.—General A. Pitt-Rivers exhibited a series of plans and relics from Mount Caburn.

Photographic Society, April 6.—J. Glaisher, F.R.S., president, in the chair.—Mr. J. H. Dallmeyer, F.R.A.S., read a paper on principles of optics involved in lantern construction; and on a new enlarging lens especially designed for use with the magic lantern, in which he described all previous existing objective lenses and condensers and the scientific principles which ought to be observed in their construction, and then exhibited and described a new condenser he had constructed containing the essentials required, viz., quantity and quality of light; also a new objective lens which gave equal definition at the margin as well as at the centre of the picture, freedom from distortion, and perfect achromatism.—A paper was read by Capt. Abney, R.E., F.R.S., on the use of silver iodide in a gelatino-bromide emulsion, showing that the introduction of iodide into the ordinary gelatino-bromide emulsion did not decrease its sensitiveness, as also that it permitted the use of an ordinary yellow light to work in—same as for wet collodion.—Also a paper, by W. England, on a drying box for gelatine plates.

GÖTTINGEN

Royal Society of Sciences, January 10 (continued).—On boracite, by Herr Klein.

February 7.—The affinity-grouping of old German dialects, by Herr Bezzenberger.—On physiological retrogression of ovarian egg in mammals, by Dr. Brunn.—On sexual propagation of *Dasycladus clavæformis*, Ag., by Herr Berthold.—The theory of numerical-theoretical functions, by Prof. Cantor.—On a class of functions of several variables which arise by inversion of the integral of solution of linear-differential equations with rational coefficients, by Herr Fuchs.

March 6.—On the theory of partial linear differential equations, by Dr. Krankenhagen.

VIENNA

Imperial Academy of Sciences, January 22.—The following papers, &c., were read:—The Diptera of the Imperial Museum in Vienna, by Prof. Brauer.—On projectivities and involutions in plane rational curves of the third order, by Prof. Weyr.—The periods of springs, by Herr Klönne.—On the behaviour of phenanthrenchinon towards ammonia, by Prof. Sommaruga.—On chlorhydrate of morphin, by Herr Tausch.—The more recent deposits on the Hellespont, by Prof. Neumayr and Herr Calvert.—Survey of the geological relations of a part of the Ægean coast lands, by Prof. Neumayr, Dr. Bittner, and Fr. Teller.

February 5.—Communications from the Embryological Institute of Vienna University, by Prof. Schenk.—The respiratory apertures of the Marchantiaceæ, by Prof. Leitgeb.—On nectar-secreting trichomes of some species of *Melampyrum*, by Prof. Rathay.—On the yearly period of the insect-fauna of Austria-Hungary. V. Rhynchota, by Herr Fritsch.—Electric action on the form of flames, by Herr Goldstein.—On the probable errors and the available results of calculation deduced from imperfect numbers, by Dr. Rotter.—Tables of observations at the Central Institution for Meteorology and Magnetism.

PARIS

Academy of Sciences, May 3.—M. Edm. Becquerel in the chair.—The following papers were read:—On the transcendants which play a fundamental part in the theory of planetary perturbations, by M. Tisserand.—On the gases retained by occlusion in aluminium and magnesium, by M. Dumas. While silver imprisons oxygen, aluminium and magnesium specially retain hydrogen. The substances were heated to a high temperature *in vacuo*. The 89·5 c.c. gas given off by 200 gr. aluminium (representing 80 c.c.) at 17° and 755 mm., contained 1·5 c.c. CO_2 and 88·0 c.c. H.; 20 gr. magnesium gave 12·3 c.c. H. and 4·1 c.c. CO. (In another case there was both CO and CO_2.) The whole of the magnesium was volatilised and condensed in stalactites (in great purity) about the neck of the retort.—On the cholera of fowls; study of the conditions of non-recurrence of the malady, and of some others of its characters, by M. Pasteur. The extract of a filtered culture-liquid of the microbe, when injected, produces sleep (for a time); the microbe seems to generate a narcotic during its life. This effect is independent of disorders produced by multiplication of the parasite in a fowl's body. The malady sometimes occurs in a chronic form.—On extension of the theory of germs to the etiology of some known maladies, by M. Pasteur. He shows reasons for attributing boils, osteomyelitis, and puerperal fever to the development of minute organisms.—On a letter of Admiral Cloué relative to waterspouts, by M. Faye.—Formation of leaves and appearance of their first vessels in Iris, Allium, Funkia, Hemerocallis, &c., by M. Trécul.—On the law of reciprocity in the theory of numbers, by Prof. Sylvester.—Experimental researches on the decomposition of some explosives in a closed vessel; composition of the gases formed, by MM. Sarran and Vieille. The products are indicated in the case (1) of pure gun-cotton (this gives, per kgm. of substance, 741 litres of gas made up of 234 CO, 234 CO_2, 166 H, and 107 N), (2) of a mixture in equal parts of gun-cotton and nitrate of potash, (3) of a mixture of 40 parts gun-cotton and 60 nitrate of ammonia, (4) of nitroglycerine, (5) of ordinary blasting-powder.—Cometary paraboloids, by Mr. Chase.—On simultaneous linear equations, and on a class of non-plane curves, by M. Picard.—On Gauss's formula of quadrature, by M. Callandreau.—Theorem on cubic and biquadratic equations, by M. Desboves.—General equation giving the relation which exists for all liquids between their temperature and the maximum tension of their vapours at this temperature, by M. Pictet.—*Résumé* of the laws which rule matter in the spheroidal state, by M. Boutigny. The fifth law, that of repulsive force at a sensible distance, is represented as the most important, because antagonistic to universal attraction. Non-volatile bodies (as pieces of wax, tallow, stearic or margaric acid, &c.), are suspended in a heated capsule, *without vapour or gas* arising from their decomposition. Water dropped, *e.g.*, from the top of the Pantheon, 70 m. high, on a heated capsule at the bottom, is repelled instantaneously by the repulsive force generated by the heat in the capsule.—Dissociation of the hydrate of butyl-chloral, by MM. Engel and Moitessier. They find here a new confirmation of the law they formulated; the dissociation of a body whose two components are volatile does not take place in presence of the vapour of one of the components at a tension above that of dissociation of the compound.—On the determination of glycerine in wines, by M. Raynaud.—On legumine, by M. Bleunard.—On gelose, by M. Porambaru.—Variations of temperature with the altitude for the great colds of December, 1879, in the valley of the Seine, by M. Lemoine. The data agree with those lately given by M. Alluard.—On the variability of teats in the ovides of the Lower Cevennes, by M. Tayon.—On the structure of some Corallidæ, by M. Merejkowsky.—On the analogies which seem to exist between cholera of fowls and nelavan, or the malady of sleep, by M. Déclot.

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