THURSDAY, FEBRUARY 8, 1877

GRIMM'S LAW

Grimm's Law: a Study. By T. Le M. Douse. (Trübner and Co., 1876.)

THIS is a very able and closely-reasoned book. Its object is to explain the cause and origin of that curious shifting of sounds known as Grimm's Law, in virtue of which a particular sound in one member of the Indo-European group of languages must answer to another particular sound in another member. The discovery of the law laid the foundation of comparative philology, and raised etymology from mere haphazard guesswork to the rank of a science, but the primary cause and reason of the law itself are still under discussion. We have still to learn why a classical aspirate must answer to a Low German media and a High German tenuis, or a classical tenuis to a Low German aspirate and a High German media.

Mr. Douse's book is intended to be an answer to this question. After criticising and rejecting the various attempts that have been made to solve the problem, he essays a fresh solution of his own. He begins by assuming that the cause of the law must be ultimately found in the principle of least effort, and therefore that no explanation of it can be considered satisfactory which does not derive the weaker sounds from the stronger ones. He then appeals to the curious fact of which the Cockney interchange of *w* and *v* is an example, and from which we learn that where one dialect is in presence of another it compensates for its mispronunciation of a sound in the latter by inverting the places of the two sounds. The same person who leaves out the aspirate where it ought to be sounded will insert it where it has no reason to exist. This is a simple case of "Cross Compensation." Grimm's Law, which involves the interchange of three sounds instead of two, is a more complicated and somewhat varying instance of the same phenomenon, and is referred by Mr. Douse to what he terms "Reflex Dissimilation." He believes, therefore, that the phonetic characteristics of the different branches of the Indo-European family were developed while they were still dialects of one and the same language, and that the characteristics once acquired were only preserved, and perhaps intensified, after the breaking up and separation of the parent tongue. The aspirates originated in the dialect which afterwards became the Low German branch, while the dialect which became the High German branch favoured the soft consonants or mediæ. Mr. Douse further holds that the parent language possessed at the outset only tenues or hard consonants. The phonology of the Lithu-Slavic branch, which agrees partly with that of the Indian section, partly with that of the Teutonic section, is explained by supposing that the dialect from which it has descended was originally in contact with the dialects of the High Germans and Indo-Greeks, and not with that of the Low Germans, and that its tenues were changed into mediæ through the influence of the High German dialect before the latter had become affected by Low German aspiration.

This is a bare outline of Mr. Douse's theory, in connection with which he has introduced a large number of subsidiary remarks and suggestions of great value and interest. It will be seen that the theory agrees better with the view of J. Schmidt, who maintains that the several members of the Aryan family of speech were originally dialects at a greater or less distance from a single centre, than with that of Fick, who would draw a sharp distinction between the East Aryan and the West or European Aryan groups. Indeed, in so far as Fick's hypothesis implies the chronological descent of one Aryan dialect from another, Mr. Douse's system is absolutely incompatible with it. Mr. Douse, however, seems to me to have fully shown the untenability of the chronological hypothesis under any form, and to have proved once for all that any satisfactory explanation of the phenomena of Grimm's Law must rest upon the belief that the phonetic systems of the various members of the Aryan group go back to a time when they were still co-existing dialects of one primitive tongue. Here as elsewhere language begins with dialectical variety, at least so far as comparative philology has any cognisance of it.

I cannot accept Mr. Douse's postulate, however, that all phonetic problems are to be tested by the principle of laziness or least effort, and that the mere fact that a hypothesis demands the change of a weaker into a stronger sound is a condemnation of it. The principle of laziness in philology can hardly be compared with the law of gravitation in physics, and allowance should be made for the contrary principle of emphasis. The healthy desire to exert oneself is nearly as strong an element in human action as the desire to escape trouble. No doubt the principle of laziness has been a most powerful agent of change in language, but it has not been the sole agent of change. The problems of speech unfortunately do not admit of so simple a solution.

This postulate leads Mr. Douse to another view, which seems to me equally unfounded. Because we can reduce by phonetic analysis the various consonants and vowels of uttered speech to a few tenues and the single vowel *a*, he concludes that the parent Aryan once contained no other sounds than these, and that there was a period when the alphabet consisted of little more than the letters *k*, *p*, *t*, and *a*. This theory of course goes along with the belief that the roots of our Aryan languages can be cut down to a combination of the vowel with a single consonant, a belief which appears to me the *ne plus ultra* of the improbabilities resulting from the prevalent doctrine of roots. There is a good deal to be said for the opinion according to which the European *a*, *e*, and *o* are not differentiated from a primitive *a*, but on the contrary the Indian *a* is the single sound into which the three vowels have coalesced.

I am compelled to part company again with Mr. Douse on the question of the two classes of gutturals which the parent Aryan is believed to have possessed. His theory is that the single tenuis *k* split up into the two varieties of pronunciation, *kw* (*qu*) in the western dialects and *ky* (*'s*) in the eastern (and Lithu-Slavic) dialects, and that originally, therefore, there was only one guttural, or class of gutturals (*k*, *g*, *kh*). M. Havet here seems to me to be more in the right in holding that the parent speech had from the beginning two classes of gutturals, one the pure *k* (*g*, *kh*) and the other a labialised *kw* (*gw*, *khw*). The pure *k* became *'s* in the Indian (and Lithu-Slavic languages, very probably, as Mr. Douse suggests, through the medium of *ky*. But in spite of his arguments to the contrary, *kw* still seems to me a harder sound than simple *k*, so that even if we accept his own test of the principle of least effort, the latter sound should be derived from the former, and not the converse.[1] He confesses himself, moreover, that his theory fails to explain the equivalence of the Sanskrit *jiv* and the European reduplicated root *gwi-gwi* "to live" (as in the Latin *vivere* and our *quick*), an equivalence which can only be accounted for by supposing that in this particular instance the Indian dialect has preserved the labial semi-vowel of the original root. Equally instructive is the equivalence of the Greek γαστήρ, and the Latin *venter* (for *gwenter*), which Mr. Douse does not notice, as it shows that Greek could sporadically deal with the guttural in the same way that Indian and Lithu-Slavic habitually did. I can see no reason why these dialects should not have sibilated *k* pure, very possibly through an intermediate *ky*, at the same time that *kw* was being reduced to simple *k*. I have heard *kyind* and *conker* from the same lips. To the instance of words with primitive *ghw* given by Mr. Douse, may be added ἐλαχύς, Lat. *levis* (for *legvis*), and βραχὺς, Lat. *brevis* (for *bregvis*).

The excellence of Mr. Douse's book has led me to dwell upon the points which seem to me open to objection, and I have left myself no space to draw attention to the many striking suggestions and new points of view scattered through the volume. I cannot, however, quite pass over the note in which he maintains the existence of bivocalised roots (*aka*, *ata*, &c.), and acutely suggests that the Greek ἐμέ and ἐκεῖνος imply dissyllabic roots as much as the archaic Latin *enos* or the Sanskrit *ana*, Lat. *olle* (for *onulus*). Mr. Douse has materially helped forward the solution of the problem of Grimm's Law, and if his theory is not secure from attack in every particular, in its main outlines it will doubtless prove correct. At all events the chronological hypothesis which derives the phonetic systems of the Indo-European languages from one another can never again be upheld.

A. H. SAYCE

STEELE'S "EQUINE ANATOMY"

Outlines of Equine Anatomy. By J. H. Steele, M.R.C.V.S. (London: Longmans and Co., 1876.)

ALTHOUGH this manual is intended, as we are informed on the title-page, for the use of veterinary students in the dissecting-room, we think it quite possible that it may have a larger sphere of usefulness.

As long as the study of zoology and comparative anatomy was confined to those who had entered on the medical profession, the human frame formed an excellent standard with which every mammalian animal might be compared in all its parts. Of late, however, since biology has been introduced into general education, those who have taken to it in earnest have not been long in finding that without a pretty thorough knowledge of the details of what may be termed the typical vertebrate structure they are on all sides beset with difficulties; they make errors in nomenclature, they cannot appreciate the significance of bony processes, and are unable to generalise with safety.

Whether it is possible that the requisite amount of detail will be mastered by those who are not stimulated by the severity of rigid examinations on the way to a professional career is a question which we will not discuss upon the present occasion; nevertheless, those teachers who are anxious that their pupils should have a reliable work on the anatomy of some one of the lower animals cannot do better than recommend the one at present under notice. The ass is an animal the expense of whose carcase is not excessive. Its size is sufficient for the easy investigation of all its important parts, and its structure is normal enough to form the basis for a competent knowledge of all the essential parts of the mammalian organisation. It is superior to the dog or the cat, because both are as a rule too small for the satisfactory demonstration of many of the more delicate systems, such as the vascular and nervous, except by those who have already had considerable experience in dissecting. Another advantage is that the requirements of the veterinary colleges *have* led to the production of such works, and there are more elaborate ones, such as that of Chauveau, the translation of which by Mr. George Fleming we reviewed some time ago (NATURE, vol. viii. p. 158), to fall back upon where greater detail is called for. On the other hand, a treatise on the anatomy of the dog would with great difficulty repay any author for the time and labour required in its production.

Mr. Steele's work commences with a chapter on the methods and terms employed. The osteology of the horse is then considered in detail, each bone being fully described. This is followed by a section on arthrology, in which the nature and action of each joint is explained. The fourth part of the volume is devoted to special anatomy, which is treated in the same way as is human anatomy in dissecting manuals generally. Appended are tables of nerves and vessels. The style in which the whole subject is treated is not inferior to that adopted in the best works on anthropotomy, at the same time that the language is clear and concise. We do not quite know why fascia should be spelt "faschia" throughout.

In his account of the liver, Mr. Steele reproduces an error found in most works on the subject. This we cannot correct better than by quoting the accurate description given by Prof. Flower in his Hunterian Lectures before the College of Surgeons in 1872.[1] There we learn that "The liver is tolerably symmetrical in its general arrangement, being divided nearly equally into segments by a well-marked umbilical fissure. Each segment is again divided by lateral fissures, which do not extend quite to the posterior border of the organ. Of the central lobes thus cut off, the right is rather [decidedly] the larger, and has two fissures in its free border dividing it into lobules. . . . . The two lateral lobes are subtriangular in form. The spigelian is represented by a flat surface between the portal fissure and the posterior [the vertebral] border, not distinctly marked off from the left lateral by a fissure of the ductus venosus, as this vessel is buried deep in the hepatic substance; but the caudate is distinct and tongue-shaped, its free apex reaching nearly to the border of the right lateral lobe. In most works on the anatomy of the horse (as those of Gurlt and Leisering) [to which

[1] Mr. Rhŷs reminds me that in the Keltic languages at any rate *kw* (*qu*) is proved to have passed into simple *k* (*c*).

[1] *Medical Times and Gazette*, August 31, 1872, p. 219.

we may add Chauveau and Steele] this has been confounded with the spigelian lobe of man."

In conclusion, we are sure that all teachers of anatomy will agree that, in an educational point of view, Mr. Steele's volume is a most valuable addition to the literature of the subject on which he treats.

OUR BOOK SHELF

Dutch Guiana. By W. G. Palgrave. (London: Macmillan and Co., 1876.)

Canoe and Camp Life in British Guiana. By C. Barrington Brown, Assoc.R.S.M. (London: Stanford, 1876.)

THESE two works deal with a small portion of a region of considerable interest from various scientific points of view, but of which we as yet know comparatively little; indeed much of the region included under the name Guiana is a *terra incognita*, and presents a fine field for an enterprising explorer. Mr. Palgrave, whose long silence since the publication of his classical work on Arabia many have wondered at and regretted, spent only a fortnight in Dutch Guiana, and this volume testifies made a diligent use of his time. The work is more connected with the historical, social, and commercial aspects of the Dutch colony than with the strictly scientific, but contains much valuable information about a country of which even the Dutch themselves, we suspect, know little. Mr. Palgrave has gathered many facts about the colony from various quarters, and ingeniously weaves these into his pleasant narrative, so that a reader who gets to the end of the little volume will have a very fair idea of its history, present condition, and future prospects. In a graphic and popular way he describes the journeys he made up the rivers near the coast, and conveys a fair idea of the productions, the people, and the aspect of the district visited. To the ethnological reader, one of the most interesting chapters is that on the Bush Negroes. Scattered all over the colony to the number, Mr. Palgrave thinks, of about 30,000, are various tribes of independent negroes, descendants of former slaves, who rose against their Dutch masters, fought for and obtained their freedom and liberty to settle pretty much where they chose, and have lived peaceably beside their former masters ever since. These Bush Negroes are descended mostly from Africans of the same type, but are now divided into three main tribes, and several subordinate branches, with chiefs and sub-chiefs, each tribe named from the place at which its treaty of peace and freedom was signed, as Aucan, Saramaccan, and Moesinga. The interesting point is that "the grouping, once made, perpetuated, and in the course of years it has produced in each instance a distinct type, till what was at first merely nominal and accidental has become permanent and real." Mr. Palgrave's work is one of great interest from beginning to end. It contains a clear map and a plan of Parimaribo.

Mr. Brown is a much better surveyor and explorer than he is a book-maker. As Government Surveyor of British Guiana, he has visited nearly every corner of it—the tracings of his routes on the map forming a regular network of blue lines—and during his journeys has collected a vast amount of valuable information about its physical aspect, geology, fauna, flora, and people. The reports on the physical features and descriptive geology of the colony have, he says, been already published by the Treasury Commissioners, and in the present volume he professes to give only a popular narrative of his travels. But the volume is something more than this, as almost every page contains notes on the fauna and flora and geological features, as well as natives that came under his observation. All these notes are put down miscellaneously in the order of time, amid the notes of the incidents that occurred during the journeys, so that it is difficult for one interested in the natural history of the country to ferret out and classify the observations. Mr. Brown would have done great service both to the general and the scientific reader, had he gathered these notes together and arranged them in an appendix, or even if he had taken care to see that his work was provided with a carefully compiled index. In another edition we hope the latter want will be supplied, as it will certainly add much to the value of the work, which, notwithstanding the defects in plan we have mentioned, is an important contribution to the information we already possess about British Guiana. Mr. Brown, it may be remembered, was the discoverer of the magnificent Kaieteur Fall, on the river Potaro, a tributary of the Essequibo, an account of which we gave in NATURE shortly after its discovery in 1870 (vol. iii. p. 108). The excellent map and well-executed illustrations add much to the interest and value of Mr. Brown's work.

The Royal School of Mines' Magazine. (London: Wyman and Sons, 81, Great Queen Street, Lincoln's-Inn Fields, W.C.)

THIS magazine, the first number of which we have just received, is to be issued three times a year, under the auspices of the students of the Royal School of Mines, and is to be devoted to articles on travel, athletics, football, and to other matters connected with the school. The present number contains several articles, by former students, on travel, an article on football, together with a record of matches played by the Royal School of Mines' Football Club, during the session 1875-76. It also contains a list of papers on mining and metallurgy; results of Royal School of Mines for 1875-76; a report of the annual dinner of the club; besides two original poems, both of which are good.

We confess we are a little disappointed that greater attention has not been paid to scientific subjects; we have no doubt, however, that this will be rectified in future, and we heartily recommend the magazine to all interested in the Royal School of Mines. J. McD. C.

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.*]

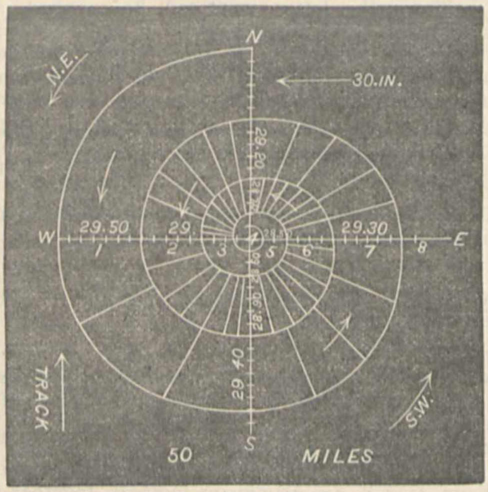
Storm Waves of Cyclones

I BEG to submit the following suggestion, to explain in a general way by the accompanying diagram the view that might be taken of the rise and great height of storm waves of cyclones at sea, such as occurred in the Bay of Bengal, and inundated and devastated extensive tracts of the coasts and islands on October 31 and November 1, 1876.

It is generally observed that when the winds blow into a re-entering angle of any sea-walls or quays, that the surge of the wave rises higher in it than against the plane sea wall, and frequently it shoots up the corner in a kind of spouting form. Again, the tides in estuaries and friths, having bell-shaped mouths facing the ocean, and contracted inner ends receiving a river, rise to very extraordinary heights, as in those of the Severn and Thames, where disastrous floods have just occurred.

These heights are much increased when the winds blow into them, as westerly into the Severn estuary, and easterly into the Thames mouth, as during the recent gales. The ordinary rise on the south coast of England of the tides is generally only about ten feet, but at Bristol they may rise to thirty or forty feet, which, in fact, would be greater than the height of any storm-wave in a cyclone in India. Now if the course of the revolving winds in a storm mass be considered as a spiral from the outside to the inside, like a coiled watch-spring, then the section of each spiral turn may be considered as decreasing from the outside to the centre inside. This will therefore resemble a long re-entering angle or estuary tube twisted upon itself as a helix, and therefore if the water be driven in at the large end and up to the small end of the spiral, it should considerably increase in height as it went along and move with greater rapidity.

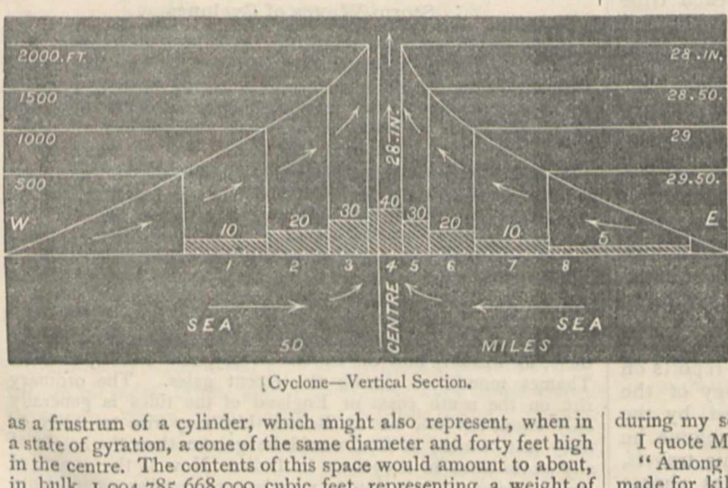
When arrived at the extremity of the spiral, it may be considered to remain there for some time and spread itself out laterally in bulk at the high level as long as the violence of the storm lasted. But when the force of the wind began to diminish, this heaped aqueous mass would more or less suddenly subside,



Cyclone—Horizontal Plan.

and rush down on all sides to seek its natural level. This might occur at sea, and be evidenced by the long swell or rollers frequently seen, or might be translated by progressive motion to launch its tremendous weight on the land, and inundate it. This, it may be conjectured, could only be effected over lands about the level of the sea, over which the base of the funnel of the cyclone would advance, carrying the inclosed mass of water with it for part of the area of the revolving circle, which would so far be still able to draw its supplies from the sea on the coast yet included in its motion. As soon, however, as the southern or equatorial limb of the circle had so far progressed as to leave the sea behind it, then the friction of the earth would prevent the inclosed mass of water following the cyclone, which had been already cut off from its aqueous communication, and it would be left behind to expand over and deluge the country lying under its level.

In speculating on the dimensions of the Bengal storm-wave we may assume, from the statements in the newspapers, that it was a disc of fifty miles in diameter and twenty feet deep, when viewed as a frustrum of a cylinder, which might also represent, when in a state of gyration, a cone of the same diameter and forty feet high in the centre. The contents of this space would amount to about, in bulk, 1,094,785,668,000 cubic feet, representing a weight of 70,339,979,169,000 lbs of sea-water, which would have flooded over a perfectly level district of a disc of about 700 miles in diameter, or 39,270 square feet in area to the depth of one foot horizontally.



Cyclone—Vertical Section.

The means for counteracting the disastrous effects of the storm or cyclone-wave in the Delta of the Ganges on life and property, would probably be found in the erection of *mounds*, as proposed by a writer in the *Times*. As this tract of country would be destitute of stone or rock, and be composed chiefly of mud and sand, it would be requisite to convert this into *bricks* first, as the mud-mounds would not stand the impact of the storm-waves, even in this country.

The design for the construction of these mounds would probably be most suitable after the model of the celebrated *Tower of Babel*, projected by the post-Diluvial inhabitants of Mesopotamia for a like purpose of self-preservation from inundation.

VORTEX

"Polar Cyclones"—Etna Observatory

IN reply to Mr. Clement Ley's letter in NATURE, vol. xv. p. 253, I fear I cannot at all agree with him as to the cause of the polar depressions of the barometer. He says: "The 'polar cyclones' appear to be themselves aggregates of those local depressions, or cyclones, which have penetrated into the Arctic or Antarctic regions, and have there partially or wholly coalesced." Now, let us test the question in this way:—Suppose the surface of our planet were all land, so that there was no watery vapour in the atmosphere; there would be no cyclonic storms, for they are due to what Espy truly calls steam power;—would the polar depressions of the barometer be observed as they are in our actual atmosphere? Mr. Clement Ley's reasoning seems to require him to say that they would not; I have no doubt that they would. The causes which produce the west winds of the middle latitudes (Maury's "counter-trades") would act as in our actual atmosphere, and their centrifugal force, in rotating round the poles, would produce a space of shallow atmosphere at and around each pole, exactly like the depression at the centre of a vortex of water, which would show itself, as at present, by a depression of the barometer.

I see in NATURE of the same date that it is proposed to form a meteorological observatory on Etna. I hope the opportunity may be taken of obtaining what is one of the greatest desiderata in the present state of meteorology—I mean a set of comparative observations of the barometer taken at two neighbouring stations, one at the sea-level, and the other at a great height. One such set, continuous or taken at short intervals, extending over a few years, and accompanied by observations of temperature and wind (the latter by self-registering anemometers), would probably give more information on the physics of barometric waves than could be obtained by any amount of observations, all taken at the sea-level. I have urged this in NATURE before, but it is so important I hope I may do so again.

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, January 20

The Boomerang

REFERRING to my letter on the "Boomerang" which you were so good as to publish in NATURE, vol. xiv. p. 248, I may, perhaps, be permitted to add a few more statements on the same subject. Concerning the use of the boomerang by the North Gippsland aboriginal natives, I have no more to add, but I have acquired some information in respect to its use among the blackfellows of South Australia, which may be of interest.

My informant is Mr. James, now a senior constable in the Victorian police, but formerly, and when I first became acquainted with him, managing a large cattle station at Blanchewater, on the borders of the so-called Lake Torrens Basin. Mr. James has had great experience among the blacks of that district during many years both before and after the time I first met with him, during my second expedition into Central Australia.

I quote Mr. James's statements to me just as I noted them:—

"Among the blacks about Blanchewater the boomerang is made for killing game. It is principally thrown among flocks of ducks, pigeons, and water-hens. It is not used often for fighting nor for killing kangaroo. They might use it in a row when short of weapons, and if their adversaries were not more than twenty or thirty yards distant. The blacks did not generally like to use them except for killing small game, as they often broke, and they have told me that their boomerangs were not 'strong enough' to kill a man. For fighting they have no throwing weapons—no throwing-sticks for their spears, but throw them by the hand, and only do so in extremity, for the spear is too valuable a weapon. It is only used as a pike; and they obtain their spears by barter from some tribe to the north. In ordinary fighting they use a weapon like a boomerang from 4 to 5 feet in length. It is held in both hands and blows are struck with the convex edge. They were not warded off when I saw it used, but the blows were struck indiscriminately—a sort of free fight. These weapons are made by themselves of boxwood.

"In throwing the boomerang I have seen it usually held nearly parallel with the horizon. When thus thrown it would rise and return towards the thrower, but the blackfellows always told me that although they could ensure its returning near them they could not tell exactly where it would come to. They could tell the direction but not the distance. If the boomerang strikes anything its course ceases.

"Some years ago the blackfellows living in the mountains just south of Blanchewater had no boomerangs and no spears. Their weapons were yamsticks and stones. They had no shields. Boomerangs, spears, and shields were acquired by them from the Blanchewater blacks, in return for which they bartered Wallaby rugs; at that time the Blanchewater and Deerie blacks had absolutely no clothing.

"This system of barter is said to have been instituted by a Hill blackfellow named Pompey, who, in 1856, was concerned in the spearing of two men at Angepina. He escaped and went north to the Deerie blacks, having first stayed some time with the Blanchewater blacks, who understood both languages, being a border tribe. He took up to the Deerie blacks some flour, sugar, tobacco, and for some time settled at Kopparamanna. He endeavoured to raise a confederacy to drive the white settlers out of the Flinders Range, and is said at that time to have instituted the system of barter.

"I knew this Pompey in 1857, when he sent another blackfellow, named Blanchewater Charley, to offer his services as 'nauto shepherd.' When Pompey then came in he told me much of the above concerning himself, which was also current among the tribes. He was a very shrewd fellow, and thus became a leader among them. He was afterwards shot for killing station-blacks. The national weapons of the Blanchewater blacks are stones. These are thrown of the size of the fist, and are perhaps thrown as far as a hundred yards, and with precision for forty yards; and in throwing, a rotatory motion is imparted to the stone. At about forty to fifty yards they can hit a small mark, such as a bottle, almost without fail. In fighting at close quarters they ward off spear blows by means of a short stick held in the hand, and if possible, in cases where the spear has been thrown, clutching it in passing with the other. They do not use a shield for stopping spears, but against stones, which, as I have said, are the national weapons."

Although much of the above cannot be said to be strictly belonging to the "boomerang," I have preferred to give Mr James's statements in full as given to me.

Much that he says corroborates the statements I have made in the letter referred to.

It is much to be regretted that no one else than myself among your readers in Australia has recorded their observations on the "boomerang," in reply to your correspondent's request.

Bairnsdale, Gippsland, Victoria A. W. HOWITT

Longmynd Rocks

MR. H. B. WOODWARD, in his "Geology of England and Wales," p. 28, states that, near Shrewsbury, the Longmynd Rocks are overlaid conformably by the Lingula Flags. I should be glad to see the evidence upon which this conclusion is based. So far as I have examined the district, the facts do not sustain Mr. Woodward's view. Arenig fossils are found at the very head of the ravines which cut back nearly to the quartzite of the Stiper Stones. The beds under the quartzite are similar in lithological character to the Arenig shales above, and I have not heard of the lower shales yielding Lingula flag fossils. At the base of the escarpment is the fault which separates the Stiper Stones rocks from the Longmynd beds. I believe the Stiper Stones beds are Arenig, in the absence of proof to the contrary. The quartzose band of the Stiper Stones may represent the arenaceous bed adopted by the Geological Survey as the base of the Arenig. CHARLES CALLAWAY

Wellington, Salop, January 15

The Measurement of the Height of Clouds

IT has always been a matter of some interest to obtain measures of the height of clouds, independently of observations made from balloons or on mountains.

During last July and August I made a series of measures of cloud-altitudes—the first, I believe, of their kind—by photographing the clouds simultaneously from different stations.

The details of the process would occupy too much space to be inserted here, but I have reason to believe that the results obtained are not as much as three per cent. in error. The cirrus clouds which I measured varied in height from 22,000 to 25,000 feet; massive cumuli from 6,000 to 7,000 feet. I did not get any good examples of cirro-cumulus or stratus. Rain-clouds appeared at all altitudes up to 4,000 feet. I hope to resume the measures at some future time. ARNULPH MALLOCH

Terling Place, Witham

Mimetic Habit of Bats

IN September, 1875, whilst paddling in a dorey (dug out boat) through a narrow and dark creek leading from Belize River, Honduras, to Reid's lagoon, we disturbed a number of small bats which were clinging to the trunks and branches of the mangroves overhanging the water. These bats were about six inches in expanse and of a grey colour so exactly corresponding with that of the trees on which they settled as to be with difficulty distinguishable even at a distance of only a few feet. They invariably *clung* to the trunk or bough *with wings expanded*, and were never, so far as I noticed, suspended from the branches.

I saw the same species in Black Creek of the same river in February last year clinging to the trees in a similar manner, and conclude it is the natural position of the animal when at rest. I send this note as I do not recollect having anywhere seen this curious mimetic resemblance and peculiar habit remarked upon.

101, Grove Street, Liverpool, January 22 S. ARCHER

THE SPONTANEOUS GENERATION QUESTION[1]

THE following paper on this subject was read at the Paris Academy of Sciences on January 8[2]:—

The Academy has perhaps not forgotten that at the *séance* of July 10 last, Dr. Bastian announced the discovery by him of the physico-chemical conditions necessary and sufficient for the spontaneous generation of certain varieties of microscopic objects of the genus *Bacteria*. The experiment which, according to Dr. Bastian, realises these conditions is very simple; it consists in exactly neutralising by liquor potassæ urine deprived of every organic germ and exposing the mixture to a temperature of fifty degrees. In those conditions certain varieties of bacteria promptly appeared.

Dr. Bastian has no doubt as to the bearing of his conclusions. To all who are attentive to medical movements it is evident that the debate relative to spontaneous generation has been removed into the domain of the etiology of contagious diseases.

I immediately repeated the experiment, and I proved, among other things, that it is sufficient to determine the saturation of the urine by solid potash instead of potash in aqueous solution (which does not modify whatever be the physico-chemical conditions to which it is subjected) for the mixture to remain perfectly sterile. I hence concluded that the interpretation given by Dr. Bastian to his experiment was totally inadmissible.

Dr. Bastian replied (*Comptes Rendus*, July 31 and August 21); he did not at all dispute the legitimacy of my reasoning, but he affirmed that I reproduced his experiment badly and exceeded the exact point of neutralisation of the urine. Such is, according to him, the cause of the sterility of the liquid in my hands.

The question is then limited to the point: Have I done anything else but replace the liquor potassæ by melted potash, and specially, have I exceeded the point of saturation of the urine, and is there anything amiss in so doing?

I have examined the debate reduced to these terms, along with M. Joubert, with all the attention of which we are both of us capable, and we are able to declare to the Academy, on the basis of new experiments, that the exact neutralisation of the urine by solid potash, which we had melted, left the urine sterile. We add, although that may not be indispensable, that there is no obstacle to the fertilisation of urine, in the experi-

[1] Continued from p. 303.
[2] Note on the Alteration of Urine in reference to Recent Communications of Dr. Bastian, by MM. Pasteur and Joubert.

ment of Dr. Bastian, in exceeding the point of saturation, even sensibly.[1]

The conclusion of my reply of July 17 last is then unassailable, consequently it is not accurate that Dr. Bastian has found the physico-chemical conditions for the spontaneous generation of bacteria.

We have examined experimentally, with not less attention, all the other points treated by Dr. Bastian in his papers of July 31 and August 21, subsequent to his original note of July 10. We are prepared to discuss them, but as they might distract attention from the main point of the debate we shall return to them later if convenient. One thing is of importance at the present moment, to know if Dr. Bastian is still convinced that urine, exactly neutralised by potash, yields microscopic organisms.

What we have said on the influence of solid potash may be repeated for liquor potassæ after it has been raised to 110°. But we wish to reply to-day to Dr. Bastian solely by the facts relative to solid potash, which suffice by themselves alone to condemn the conclusions which he has deduced from his experiments.

The reader will doubtless remark that in the preceding abstract we have scrupulously avoided introducing the word *germ* and opposing a doctrine to a doctrine. We have to do with a fact: Yes or no, does urine which has been boiled so as to be sterile, and better still, fresh, natural urine, just from the bladder, not having been submitted to any preliminary boiling—does this at 50° yield organisms after having been neutralised by potash? Dr. Bastian says yes, and this is his pretended great discovery. We say no, and we demonstrate by proving that Dr. Bastian would have obtained a result absolutely contrary to that which he published if he had made use of the substance KO,HO, which alone, in cases when it is pure or only associated with mineral matters in small quantity, has the exclusive right of being called potash.

The following reply to the above by Dr. Bastian was read at the Paris Academy, January 22[2]:—

At the *séance* of the Academy of January 8 M. Pasteur, in conjunction with M. Joubert, contributed another "Note sur l'Altération de l'Urine," in reply to the last communication which I had the honour of submitting to the Academy at its *séance* of August 21 of last year.

It may, perhaps, be permitted to me to state that an account of my researches on the fermentation of urine, much fuller than what has appeared in the *Comptes Rendus*, is now to be found in the *Proceedings* of the Royal Society No. 172, 1876; and to this paper I would particularly call the attention of all those who are interested in the question of the mode of origin of Bacteria and other related problems.

I have found, as stated in an earlier communication to the Academy, that previously sterile urine, when exactly neutralised by boiled liquor potassæ (of the British Pharmacopœia) will rapidly ferment and swarm with Bacteria, if the mixed fluids are maintained at a temperature of 50° C. M. Pasteur, after repeating my experiments with certain variations, said (*Compt. Rend.*, July 17, p. 178): "Je m'empresse de déclarer que les expériences de M. le Dr. Bastian sont, en effet, très-exactes; elles donnent *le plus souvent* les résultats qu'il indique." He then explains why he differs from me as regards the interpretation of these experimental results. It is somewhat confusing, therefore, to find M. Pasteur now saying in his most recent communication: "une seule chose importe en ce moment, c'est de savoir si le Dr. Bastian est toujours convaincu que l'urine neutralisée exactement *par la potasse* donne des organismes microscopiques?" My reply is simple. M. Pasteur has implied (*loc. cit.* p. 179) that solid potash heated only to 100° C. does lead to such an effect; I, however, have made no experiments with solid potash, though, in operating with the boiled liquor potassæ already named, I have many times obtained the result indicated, and am quite prepared to demonstrate to others the fact of the occurrence of fermentation in urine under these conditions.

In using solid potash M. Pasteur departed from the conditions of my experiments in a way which was wholly needless. It will be found much more convenient for others to repeat them exactly. Seeing that a strong solution of potash in suitable quantity can be easily heated in a closed glass tube to the temperature which M. Pasteur desires (110° C.), there is absolutely no reason for substituting solid potash as he has done. The *liquor potassæ* used by me has always been procured from Mr. Wm. Martindale, of 10, New Cavendish Street, London.

In his "Note" of July 17, the interpretation given by M. Pasteur of my results was that the liquor potassæ used by me immediately after it had been heated to 100° C. induced fermentation in the urine because it contained living germs not killed at this temperature of 100° C., but which would have been killed had the potash solution been heated to 110° C. M. Pasteur has strangely understood my meaning if he thinks, as he now intimates, that I have not contested the legitimacy of his reasoning. I am very far from regarding it as "irreproachable," and that for reasons which I have previously given. If, however, I have not been able to make myself understood it will be well for me to repeat the reasons on account of which I still absolutely reject M. Pasteur's interpretation. They are these:—(1) It is to me incredible that a fluid so caustic as the strong liquor potassæ which I have employed could contain living germs after it has been raised to 100° C., and it is not too much to ask that he who makes such an assertion should prove it; (2) that liquor potassæ (*when added in proper quantity to the urine*) is just as efficacious after it has been heated to 110° C. as when it has only been heated to 100°; (3) the decisive proof that liquor potassæ previously heated to 100° does not induce fermentation in sterile urine by reason of its containing living germs, is to be found in the fact that the addition of one or two drops of it only (when much more would be required for neutralisation), subsequently leaves the urine as barren as if no solution of potash had been added; whilst if the liquor potassæ really induced fermentation in the cases mentioned above (2) because of its containing living germs, then one or two drops of it would always suffice to infect any quantity of sterile urine to which they may have been added.

In his last communication to the Academy, M. Pasteur says:—"La question se trouve donc limitée à la connaissance de ce point:—Ai-je fait autre chose que de remplacer la potasse en solution par de la potasse fondue, et notablement, ai-je depassé le point de saturation de l'urine, et y a-t-il quelque inconvénient à le faire?" To these three questions I reply as follows:—(1) Yes, too much potash was also added; (2) Yes, in those experiments in which you obtained negative results, you expressly state that potash was added in quantity sufficient to render the fluid "alcaline" *Compt. Rend.* t. lxxxiii. pp. 179 and 377; (3) Yes, according to my experience, any amount of potash beyond what is sufficient to neutralise the urine in its unboiled state is decidedly prejudicial to the inducement of fermentation, and I have especially cautioned experimentalists on this subject (see *Proceedings* of Royal Society, No. 172, pp. 152 *note* †, and 155.

I would also call M. Pasteur's attention to the fact that in his last communication to the Academy, as printed in the *Compt. Rend.* for January 8, on the two occasions on which he professes to describe my experiment, he does it inaccurately. Thus, on p. 65, lines 2 and 3, and also on p. 66, in the sixth line from the termination of his note, he omits to mention the important fact that the added liquor potassæ was previously boiled.

Further discussion between M. Pasteur and myself seems to me in the present phase of the question to be almost useless. Certainly, no good can come from our alternate enunciation of opposite experimental results, when precisely the same methods have not been had recourse to. For my own part I am perfectly ready to reproduce before competent witnesses the results of which I have above spoken; or, failing this opportunity, I shall also be content patiently to await the ultimate decision of other properly informed fellow investigators, both here and on the Continent, as to the correctness of the facts which I have had the honour of announcing to the Academy.

[1] It is not useless to say here that, contrary to what is generally admitted, urea in aqueous solution or in urine is decomposed at 100° C. and even at temperatures much lower. The product of decomposition is carbonate of ammonia.

[2] On the Fermentation of Urine: Reply to M. Pasteur. By Prof. H. C. Bastian.

JOHANN CHRISTIAN POGGENDORFF

SCIENCE has lost one of her most diligent and devoted servants by the death of Prof. Dr. J. C. Poggendorff, in Berlin, on January 24. He was born in Hamburg on December 29, 1796. The early deaths of both parents forced him at a comparatively tender age to engage in the rougher conflicts of life; a circumstance which, however, contributed in a great measure to the rapid development and maturity of his mental powers. At the age of sixteen he entered the establishment of a pharmaceutical chemist, and was actively engaged for eight years in this occupation. His hours of leisure were devoted to scientific study, and his aspirations gradually rose above the narrow limits in which he was confined. These longings were gratified in 1820, when he was enabled to enter the University of Berlin as a student of physics. With restless energy Poggendorff entered upon his chosen field and quickly gave evidences of more than ordinary talent. In 1821 Oken's *Isis* contained his first paper, "Physico-chemical Investigations upon the Magnetism of the Voltaic Pile." In this article he describes his discovery of the electromagnetic multiplier or galvanometer, formed by carrying a wire several times round a magnetic needle in a vertical plane; an apparatus which with Schweigger's later improvements, is in universal use. Other articles on closely-allied subjects appeared at this period in Gilbert's *Annalen*. The abilities of the young physicist were soon recognised, and he received from the Royal Academy of Sciences at Berlin the post of "observator," which enabled him to continue his scientific investigations. The leading *savants* of the day—G. Rose, H. Rose, v. Buch, Alexander v. Humboldt, Mitscherlich, and others—gave him also a warm welcome into the circle of their friendship.

In 1824 Poggendorff conceived the plan of issuing a new physico-chemical journal on a more extensive basis than any other hitherto existing in Germany. The above-mentioned investigators, as well as Berzelius, Arfredson, Bonsdorff, and other prominent foreign chemists and physicists promised a hearty co-operation in the new enterprise. Before the completion of the preparations, the death of Prof. L. W. Gilbert, of Leipzig, who for twenty-five years had issued Gilbert's *Annalen der Physik*, left that periodical without an editor. Poggendorff entered at once into negotiations with the publisher. The result was that he edited the seventy-sixth and closing volume of Gilbert's series, and then issued the first number of the *Annalen der Physik und Chemie*. This was the decisive step of Poggendorff's life. Although but four years had elapsed since the commencement of his university studies, he brought to the new undertaking a breadth of knowledge, a keenness of discrimination, and a true love and enthusiasm for his work which, united with the warm co-operation of leading investigators, gave the *Annalen* at once a prominent position among scientific periodicals. The somewhat exacting duties of the new position did not prevent the continuance of his researches. In 1827 he invented the magnetometer for the measurement of minute magnetic variations. At this time, also, papers appeared from him on the vibrations of light, on the aurora borealis, on the law of diffusion of gases, on the decomposition of chemical compounds, on the relations between the elements of ternary compounds, &c., all of which evidenced a comprehensive grasp of the varied departments of chemistry and physics. In 1834 he received the degree of Ph.D. from the University of Berlin, and in 1844 the degree of M.D. from the University of Königsberg. In 1834 he was elected to the position of extraordinary professor of physics at Berlin, in which relation he continued to the time of his death. The Royal Academy of Sciences at Berlin elected him to membership in 1839, and the most important of his subsequent researches were published in the *Transactions* of the Academy. These were confined almost exclusively to galvanism and electricity, and form altogether one of the most valuable and extensive contributions which has been made to our knowledge in this department. His labours were chiefly directed to the study of electro-chemical and thermo-electric phenomena, methods of measuring the intensity of the galvanic current, the laws of galvanic polarisation, the resistance of various conducting mediums, &c., as well as the invention of numerous pieces of apparatus applicable in this branch of physics. In 1837 Prof. Poggendorff was actively engaged with Liebig in the preparation of the first volume of the well-known "Handwörterbuch der Chemie," but was unable to continue his co-operation in the succeeding volumes. A series of biographical sketches, "Lebenslinien zur Geschichte der exacten Wissenschaften," appeared from his pen in 1853, and were followed in 1863 by a compendious "Biographisch-literarisches Handwörterbuch zur Geschichte der exacten Wissenschaften." This book of about 3,000 pages includes the biographies and fragments of works and papers of the scientific men of all nations and all times, and involved an immense amount of time in the preparation.

Valuable as were the experimental results and encyclopædic labours of Prof. Poggendorff, they assume a subordinate position by the side of the great life-work on which his energies were chiefly expended. In the long series of over 160 volumes of the *Annalen der Physik und Chemie*, he has left behind him the most enduring monument to his zeal and devotion in the cause of science. His rare combination of talents, his fine critical powers, his unflagging industry, and his long period of service render his scientific editorial career strikingly similar to that of the recently-deceased founder and editor of the *Revue des deux Mondes* in the world of politics and letters. The translation of the articles of foreign investigators formed no small part of his editorial labours. The seventy-six contributions of Faraday alone occupy between two and three volumes, those of Brewster and Regnault require each over a volume. It has been calculated that about one-fifth of the total number of volumes of the *Annalen* would be occupied alone with the editor's translations. The original plan of making the *Annalen* a complete record of all advances made in both chemistry and physics gradually became impossible, as the opportunities and incitements for original research increased. With the appearance of the various chemical serials in Germany, the department of chemistry became less and less prominent, until the *Annalen* has assumed an almost purely physical character.

Ever watchful to detect and recognise merit in fellow-labourers, he stood upon peculiarly intimate and friendly relations with a large proportion of his extensive staff of contributors. Their feelings of love and respect found opportunity for expression three years ago, when many of them gathered to celebrate the fiftieth anniversary of the foundation of the journal. The occasion was very fitly observed by the presentation to the aged editor of a jubilee volume of the *Annalen*, compiled under the direction of the contributors, and containing special articles from a number of leading physicists. The hope then expressed that it might be followed by many more volumes under his editorship was not destined to be fulfilled. He had reached his eighty-first year with unimpaired possession of mental and physical powers, when death suddenly removed him from his sphere of earnest, useful activity, after a brief and painless illness. A large assembly of men famous in literature and science, gathered at the burial ceremonies, to pay the last tribute to the memory of their departed friend. It is not alone in science that Poggendorff will be missed. His kindly, genial, appreciative disposition endeared him in the hearts of men from all classes of society; and the generous hospitality of his home will not easily be forgotten by those who have learned to know him in the midst of the family circle.

T. H. N.

THE NEW STAR IN CYGNUS

THE following three letters are published in *the Astronomische Nachichten*, Nos. 2115, 2116:—

On December 3 I received the news of the discovery of the new star in Cygnus, but the unfavourable weather did not allow me to search for it till the 5th.

The star on that day, when the sky cleared up for a few hours, was of magnitude, 4-5; it appears then to have decreased considerably in brightness, for Schmidt estimated the star on November 24, at magnitude 3. The colour of the star is not remarkable—yellowish-red; the spectrum is one of the most interesting that I know. It is the coloured band crossed by numerous (from eight to ten) dark bands, and besides there are several bright lines visible.

I have prepared an accurate drawing of the spectrum, which exactly agrees with a drawing made shortly before by Dr. Lohse. At the very first sight the spectrum of the new star appeared to me entirely different from those of the reddest stars, and a later accurate comparison with the drawing has enabled me to discover no satisfactory connection either with the so frequently met with band spectrum III.*a*, or with the rare class III.*b* (Secchi's type, III. and IV. respectively). Of the bright lines there was one specially conspicuous in the farthest red, as also one on the boundary of the green and blue, and two lines in the blue. In the yellow and green appeared some very bright stripes (? bands), which I, however, cannot consider proper bright lines (of which the specimen of glowing gas consists), but of which I believe there are places in the spectrum, which, by contrast with the neighbouring dark absorption bands, stand out conspicuously. In the case of the very marked band spectra of Class III.*a*, one has very often, and especially with a disturbed sky, the impression that there are bright lines in the spectrum, while with favourable atmospheric conditions, it is clearly perceived that regions of the spectrum deficient in lines in the neighbourhood of dark bands produce that impression.

The observations were made by means of a small spectroscope formerly described by me. With a larger Browning instrument some measurements were later attempted, and one of the bright lines undoubtedly recognised as the second hydrogen line F. The lines in the blue gave the wave-lengths 474 and 470 mill. m.m. Bright places in the spectrum (very possibly bright lines) were further observed with 512 and 498 mill. m.m. wave-lengths. We did not manage to measure the red lines.

In further characterising the spectrum, I might state that the blue and violet, in comparison with other stars which showed a band spectrum, was very well seen, and that, at all events, in consequence of the proportionally small general absorption which this part of the spectrum undergoes, the colour of the star differs little from the mean star colour.

On December 8 I succeeded in confirming and completing the observations herewith sent. I estimated the star at magnitude 5—perhaps it was even less. By means of the small spectroscope several measurements were obtained of bright lines and stripes (? bands) of the spectrum; especially was it possible to observe very accurately the position of the red lines, and to identify them with the red hydrogen line C. The following further measurements were made:—

Wave-lengths.	
587–589	Bright lines.
469–470	Bright stripes, very possibly bright lines.
526–528 (E)	Bright stripes, very possibly bright lines.
513–514	Bright stripes, very possibly bright lines.
507–509	Bright stripes, very possibly bright lines.
497–499	Bright stripes, very possibly bright lines.
485–486 (F)	Bright line.

The state of the atmosphere was bad, and very often the observations were interrupted by clouds for a long time. The double numbers for the wave-length should indicate the limits within which the particular line lies according to the measurements. It is hereby evident that besides the hydrogen lines C and F the line D_3 (wave-length 487–5) appears bright in the spectrum of the star. The magnesium line (6) I have not been able to see bright, but I have repeatedly measured a bright stripe, somewhat more broken than 6, which very possibly is identical with a bright line which, under special circumstances, stands out as the brightest line in the spectrum of the hydrocarbons. A line appeared to me to shine out temporarily in the violet, apparently the third hydrogen line in the neighbourhood of G.

I hope to be able, ere the star becomes too weak for spectroscopic research, to obtain some more accurate measurements in the positions of the bright lines.

I may in conclusion add the remark that in the constellation Cygnus there are three stars,[1] whose spectra are without parallel; we have therefore, in a tolerably circumscribed space of the sky, including Schmidt's new star, four objects which give a spectrum entirely differing from the many hundred stars examined hitherto.

H. VOGEL

Since the receipt of the first account of Dr. Schmidt's Nova the weather here has generally been of the most unfavourable character, and it was not until January 2 that the new star could be examined with the 15-inch refractor of this observatory. On the evening of that day the Nova was of about the seventh magnitude and of a decided red colour. The spectrum, as shown in a spectroscope of Dr. Vogel's construction, was of surprising brilliancy, and consisted of a faint continuous spectrum interrupted by five bright lines. The positions of these lines determined in parts of the scale of the instrument, and afterwards reduced to wave-lengths by comparing the spectra of moonlight and various elements are as follows:—

		Mill. m.m.	
No. 1	W. L.	655	Intense bright red.
2		581	Middle of a rather bright band in the yellow, fading off rapidly on both sides.
3		504	Bright, well-defined line.
4		486	,, ,, ,,
5		456	Faint line in the violet.

It is remarkable that four of these wave-lengths agree closely with those of bright lines previously observed. Nos. 1 and 4 are obviously the C and F lines of the hydrogen spectrum. No. 3 coincides almost exactly with the brightest line of gaseous nebulæ, and lastly, No. 2 corresponds very nearly with one of the bright lines in the spectra of the three remarkable stars in the Swan, pointed out by Messrs. Wolf and Rayet, and subsequently observed by Dr. Vogel (see *Berichte d. Königl. Sächs. Ges. der Wiss. Math. Phys. Cl.*, 1873, p. 556 ff.). As yet it has been impossible to confirm the above results, but considering the great interest of the subject I venture to lay this imperfect account before the readers of the *Astronomische Nachrichten.*

RALPH COPELAND

Lord Lindsay's Observatory, Dunecht, January 8

Yesterday night I observed the star of M. Schmidt; it was about the seventh or eighth magnitude, of a colour tending to greenish, but yellower than on the preceding day. The spectrum is formed of two strong lines, of which one corresponds to hydrogen and the other to magnesium. The sodium was still more marked and bright. There was besides another line in the violet, probably also hydrogen. The red of this gas is very weak and does not bear measurement. Besides these four very beautiful lines there were a number of small lines between D and the magnesium, but the space where are the two bright lines of magnesium and the F and the H is almost devoid of light. After these two bright lines towards the violet there is a dark gap, and then follows a group of very fine lines. So that the description given by M. Cornu is correct: only the bright lines are not bordered by nebulosity, but are as perfectly defined as the bright lines of nebulæ.

Rome, January 9 P. A. SECCHI

[1] B.D. No. 4001, 40013 + 35°; 3956 + 36°; by Wolf and Rayet discovered, by me accurately examined. Communicated to the *K. Sächs. Gesellsch. der Wiss.*, December 12, 1873.

FERTILISATION OF FLOWERS BY INSECTS[1]

XV.

Alpine Species of Gentiana.

IN previous articles I have attempted to show that in the Alpine region Lepidoptera are relatively much more frequent visitors and fertilisers of flowers than in the plain and lower mountain region; and that, in connection with this fact, in the Alpine region certain flowers are found adapted to cross-fertilisation by butterflies and moths, the nearest allied of which, inhabiting the plain or lower mountain region, are adapted to cross-fertilisation by bees. As a further confirmation of this statement, we may consider the genus Gentiana, which, besides some species inhabiting the plain and lower mountain region, includes various beautiful Alpine forms. The former, *G. cruciata*, *G. pneumonanthe*, and *G. ciliata*,[3] are all adapted to cross-fertilisation by larger Apidæ, chiefly by humble-bees, whereas in the Alpine region, besides many species adapted to humble-bees and one accessible to insects of all orders, there are also numerous species adapted to Lepidoptera.

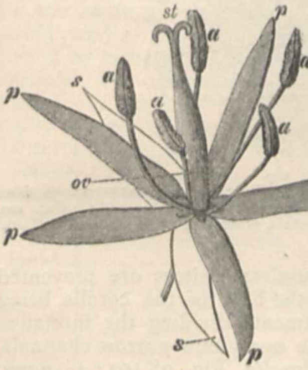


Fig. 94

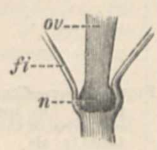


Fig. 95.

Figs. 94, 95.—*Gentiana lutea*, L.—Fig. 94.—Whole flower, a little magnified, seen obliquely from above. Fig. 95.—Undermost portion of the ovary, showing the nectary and two filaments.[2]

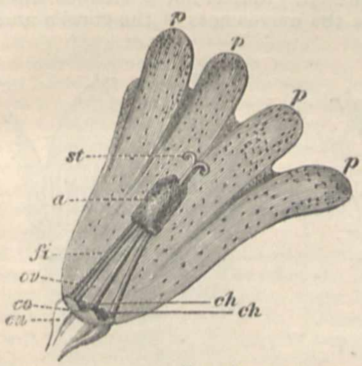


Fig. 96

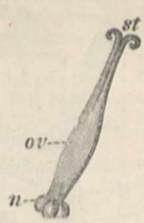


Fig. 97.

Figs. 96, 97.—*Gentiana punctata*, L.—Fig. 96.—Flower in its natural position (nearly 1½ : 1), the anterior part of the corolla having been removed, as far as the filaments, which are not united with it. Fig. 97.—Pistil of the same flower.

It may be worth while considering by what modifications of structure the adaptation of one and the same genus to such different visitors has been effected.

1. *Alpine Species of Gentiana accessible to Insects of all Orders.*—By far the most simple structure of flowers among all the Gentianæ is to be found in *G. lutea* (Figs. 94, 95), which may therefore perhaps be considered as the nearest allied to the common ancestor of the whole genus. Its flowers are perfectly open; the anthers and stigma are developed simultaneously, and in some flowers one of the anthers is found in contact with the stigma, so that self-fertilisation is by no means excluded. The honey—being secreted by an annular swelling of the base of the pistil (*n*, Fig. 95) so copiously that a large drop of it completely covers the excavated base at each of the five petals and touches the two neighbouring filaments—is visible and accessible to flying insects of all orders, whilst ants and other insects creeping to the flowers are frequently prevented from gaining the honey by the basal lobes of the opposite leaves uniting round the stem, so as to form a kind of basin in which rain-water is collected.[1]

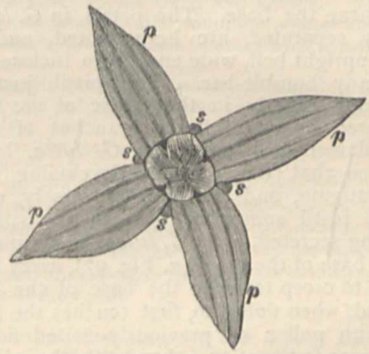


Fig. 98.

Figs. 98-102.—*Gentiana tenella*, Rottb. (*glacialis*, Thom.).—Fig. 98.—Flower seen from above (3½ : 1). Fig. 99.—The middle part of the same flower (7 : 1). Fig. 100.—Lateral view of the same flower (3½ : 1). Fig. 101.—A piece of the corolla with the adherent filaments and nectaries. Fig. 102.—Flower bisected longitudinally (3½ : 1).

The splendid yellow colour of the large flowers, which are grouped in numerous whorls round stems of more than a man's height, makes them more conspicuous than the flowers of any other species, and attracts plenty of various insects, which alight on these flowers for honey and for pollen.[2] Some of them alighting in the middle of the flower will first touch the stigma and dust it with pollen from previously-visited flowers, and thus effect cross-fertilisation. This, however, is by no means secured, and many flowers, in spite of numerous visits of insects, may remain quite unfertilised by them, so that the possibility of self-fertilisation above alluded to is probably not useless to the plant.

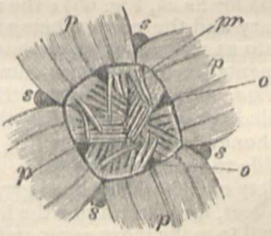


Fig. 99.

2. *Alpine Species of Gentiana adapted to Humble-bees.*—

[1] Continued from vol xiv., p. 175.

[2] The following explanation of the lettering applies to all the figures:—*a* = anthers, *ca* = calyx, *ch* = channels conducting to the honey, *co* = corolla, *fi* = filaments, *n* = nectary, *o* = openings conducting to the honey, *ov* = ovary, *p* = petals, *pr* = protecting hairs (Sprengel's Saftdecke), *s* = sepals, *st* = stigma.

[3] *G. campestris*, *germanica*, and *amarella*, inhabit the Alpine region, the mountain region, and the plain.

[1] See Kerner, *Die Schutzmittel der Blüthen gegen unberufene Gäste*. Wien, 1876, p. 207.

[2] Only once have I had the opportunity of watching *G. lutea*, in the Roseg Valley, near Pontresina, July 29, 1876. Here I found its flowers visited by Coleoptera: *Malthodes flavoguttatus*, some specimens; *Anthiophagus alpinus*, numerous specimens; *Epuraea aestiva*, in the largest number; Diptera: some species not yet known to me; Lepidoptera: *Agrotis ocellina*, pretty frequently, sucking; Hymenoptera: *Tenthredo* species (similar to *T. notha*), some specimens; *Anthiophora* spec., not yet known to me, some specimens; and once, *Bombus pratorum*, ☿, the last two both sucking and collecting pollen.

From flowers so simple as those of *G. lutea*, which openly offer their honey to all flying insects, but, in spite of their extraordinary conspicuousness, are incapable of securing cross-fertilisation by the various visitors, the genus Gentiana advances to such species as exclude from the honey the majority of the less industrious visitors, and at the same time compel the most industrious of the larger Apidæ, chiefly the humble-bees, to effect cross-fertilisation, whenever they fly from flower to flower. By what modifications of structure this improvement has been effected, may at once be seen in Fig. 96, which represents a flower of *Gentiana punctata*, longitudinally bisected from above to near the base. The petals, in *G. lutea*, nearly completely separated, are here united, and form an obliquely upright bell, wide enough to inclose the whole body of any humble-bee. The pistil, just as in *G. lutea*, stands exactly in the centre of the flower, and is terminated by two reflexed branches of the stigma, but the filaments, diverging in *G. lutea*, here incline together, so that the anthers, developing some time after the stigma, and dehiscing extrorsely, closely surround the pistil somewhat beneath the stigma. The honey being secreted, as in *G. lutea*, by an annular swelling at the base of the pistil (*n*, Fig. 97), every humble bee is induced to creep towards the base of the bell-shaped corolla, and, when doing so, first touches the stigma and dusts it with pollen of previously-visited flowers, thus effecting cross-fertilisation; then with the same portion of its hairy body it touches the anthers and charges itself with fresh pollen. The exclusion of the majority of use-

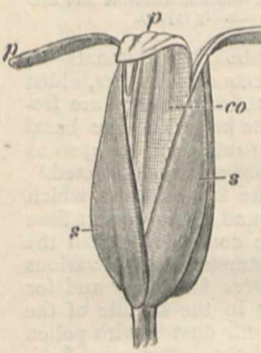


FIG. 100.

FIG. 101.

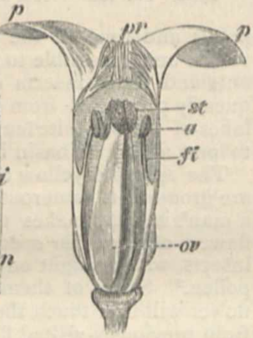


FIG. 102.

less visitors from the honey is effected by the base of the corolla being constricted, and the base of the filaments united with it (as far as *ch*, Fig. 96); the narrow interstice between the ovary and the corolla being thus divided by the filaments into as many narrow channels as there are petals and filaments (in *G. punctata* commonly seven, in *G. acaulis*, *excisa*, and others five). By these narrow channels humble-bees may easily pass their proboscides as far as the honey, whereas saw-flies, flies, and most beetles are unable to reach the honey.

Thus the variety of visitors has been greatly diminished; but the humble-bees, for which alone the honey is reserved, are hence induced to make more eager and frequent visits; and, as by these visits not fortuitously, as in *G. lutea*, but regularly pollen is brought from one flower to the stigma of another, cross-fertilisation in the species of this group is far more certain than in *G. lutea;* and the possibility of self-fertilisation, indeed, seems to have been lost.

Of twenty-six species of Gentiana inhabiting Germany and Switzerland, eleven belong to the present group, which must almost necessarily be cross-fertilised by humble-bees; namely, besides the three above-mentioned species inhabiting the plain and lower mountain region, the following eight Alpine ones: *G. punctata*, *purpurea*, *pannonica*, *asclepiadea*, *Frœlichii*, *frigida*, *acaulis*, and *excisa*. But hitherto only three of these eleven species have been actually observed to be visited and cross-fertilised by humble-bees, namely, *G. acaulis*, by Ricca ("Atti della Soc. Ital. di Sc. Nat.," xiv. 3, 1871), *G. pneumonanthe* (H. Müller, "Befruchtung," p. 333), and *G. excisa*,[1] by myself.

3. *Alpine Species of Gentiana, adapted at the same time to Apidæ and to Lepidoptera.*—Whilst in the foregoing

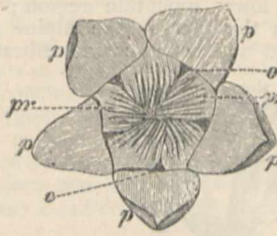


FIG. 103.

FIGS. 103-105.—*Gentiana nana*, Wulf.—FIG 103.—Flower seen from above (7 : 1). FIG. 104.—The same flower bisected longitudinally. FIG. 105.—A piece of the corolla, with petals, protecting hairs, stamens, and nectaries (7 : 1).

group Diptera and other useless visitors are prevented from gaining the honey by the base of the corolla being constricted and by the filaments dividing the interstice between the corolla and the ovary into narrow channels, in the present group (*G. tenella*, Fig. 98-102; *G. nana*, Fig. 103-105) the same effect has been attained by the entrance to the tubular corolla being barred by hairs (*pr* Fig. 98, 99, 102-105), between which only four or five small openings (*o*, Figs. 99, 103) are to be seen. The corolla, in the previous group wide enough to inclose the whole body of a humble-bee, is here so narrow that any proboscis attempting to reach the honey will graze the stigma and the anthers, and, when passing from flower to flower, will effect cross-fertilisation. But only Apidæ will be enabled to thrust their proboscides between the protecting hairs, and only Lepidoptera have proboscides slender enough to penetrate the small openings. Thus, in these flowers the visits of Lepidoptera are useful for the cross-fertilisation of the plant, while in the foregoing group they are useless.

Most probably the present group is not descended from the foregoing; besides the narrowness of the corolla and

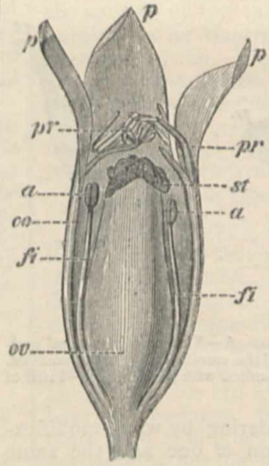


FIG. 104.

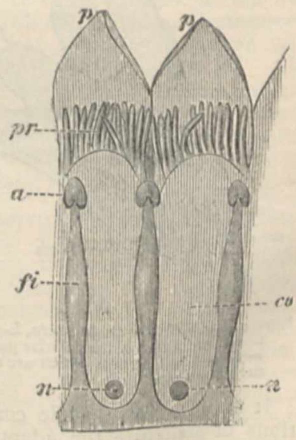


FIG. 105.

the protecting hairs, the position of the nectaries is so peculiar to this group, that it is rather to be considered

[1] I found, in the Alps, *G. excisa* visited and cross-fertilised by *Bombus lapponicus*, *F.*, and *B. mendax*, Gerst. Once, in the Albula Pass, July 28, 1876, I saw a moth, *Plusia hochenwarthi*, creeping into a flower and sucking its honey, but without touching stigma or anthers. Also some small Diptera and three specimens of a small beetle, *Haltica melanostoma*, Redt., can only be registered as useless guests.

as a separate branch, diverging from the common stem of the genus Gentiana, even before *G. lutea*. For whilst in all other species of Gentiana the honey is secreted by an annular swelling of the base of the pistil, in this group the nectaries are situated at the base of the corolla itself, between the filaments (*n*, Figs. 101, 105). As hitherto *G. tenella* and *G. nana* have been distinguished only by somewhat fluctuating characteristics, it may be of especial interest that in *G. tenella* I have found each interstice between two filaments to contain two nectaries (*n*, Fig. 101), in *G. nana* only a single one (*n*, Fig. 105).

To the same group belong *G. campestris*, *germanica*, *amarella*, and *obtusifolia*, two of which have been directly observed by myself to be visited both by Lepidoptera and butterflies. For instance, near Pontresina and in the Val del Fain, August 6-8, 1876, I saw *G. campestris* repeatedly visited by *Bombus mendax*, Gerst. ☿, but also by butterflies (*Argynnis pales*, *Hesperia serratulæ*, *Colias phicomone*, *Lycæna argus*).

The fourth group of Alpine species of Gentiana exclusively adapted to cross-fertilisation by Lepidoptera, will be treated of in my next article.

Lippstadt HERMANN MÜLLER

(*To be continued.*)

DEEP SEA MUDS[1]

DURING the present session I propose to lay before the Society several papers on subjects connected with the deposits which were found at the bottom of the oceans and seas visited by H.M.S. *Challenger* in the years 1872, 1873, 1874, 1875, and 1876.

Instruments in use for obtaining information of the deposits.

It will be convenient to introduce this first communication with a brief description of the instruments and methods employed on board H.M.S. *Challenger* with the view of obtaining information and specimens of these ocean deposits. The instrument in most frequent use was the tube or cylinder forming part of the sounding apparatus.

During the first six months of the cruise this cylinder was one having less than an inch bore, and was so arranged with respect to the weights or sinkers that it projected about six inches beneath them. The lower end of the cylinder was fitted with a common butterfly valve. This arrangement gave us a very small sample of the bottom.

In July, 1873 this small cylinder was replaced by one having a two-inch bore, and it was also made to project fully eighteen inches below the weights. This was a great improvement, as it gave a much greater quantity of the bottom in most soundings.

The tube was, in the clays, frequently forced nearly two feet into the bottom. On its return to the ship, the butterfly valves were removed, and a roll of the clay or mud, sometimes eighteen inches in length, could be forced from it. In this way we learned that the deeper layers were very frequently different from those occupying the surface.

In the organic oozes—as the Globigerina, Pteropod, Radiolarian, and Diatom oozes—the tube did not usually penetrate the bottom over six or seven inches, these deposits offering more resistance than the clays and muds. Occasionally the tube came up without anything in it, but the outside was marked with streaks of the black oxide of manganese. In about thirteen out of nearly four hundred soundings we did not get any information of a reliable nature about the deposit.

The dredge in use was a heavy modification of Ball's naturalist's dredge, and the trawl was the ordinary beam trawl of the fishermen.

Both of these instruments had generally a bag of canvas or other coarse cloth sewed into the bottom of the netting, to prevent the soft clay or ooze from being entirely washed out. In this way we, at many stations, got, along with animals, a large quantity of ooze, clay, stones, or manganese nodules.

While trawling or dredging the ship often shifted her position a mile or two, but we could not tell whether the dredge or trawl had been working over all that distance, or had merely taken a dip into the deposits. This should be remembered when comparing the captures in one locality with those of another.

Altogether there is much uncertainty about the behaviour of the trawl and dredge in deep water. It occasionally happened that when the greatest care was taken, and when it was believed that the trawl had been dragging for some hours, it came up without anything in it, or any evidence upon it or in the attached tow-nets to show that it had been on the bottom.

During the last year of the cruise a tow-net was attached to the dredging line just below the weights, which last were placed a few hundred fathoms in front of the trawl or dredge. Tow-nets were also attached to the trawl and dredge. These nets frequently came up nearly full of mud, and almost always contained minute things and fragments from the surface layers of the bottom.

At times the water-bottle attached to the sounding line came up with clay or ooze in it, or had some of the deposit adhering to its under-surface.

These then were the means and methods employed for getting information concerning ocean deposits, and collectively they have furnished us with a large amount of material. A careful examination of the specimens procured has already much increased our knowledge of the nature and distribution of ocean deposits, of the sources of the materials of which they are built up, and of the chemical processes taking place in the deep waters and on the floor of the ocean.

The Volcanic débris in Ocean Deposits and some of the Products of its Disintegration and Decomposition.

In a preliminary report to Prof. Wyville Thomson, which has been published in the *Proceedings* of the Royal Society of London, I pointed out the wide-spread distribution of volcanic *débris* in ocean deposits, and its probable influence in the formation of deep sea clays, and manganese nodules or depositions. In this paper I propose to treat of these subjects in more detail, and to give some of the results of observations which have been made since the above report was written.

Pumice-Stones.

The form of volcanic *débris* most frequently met with in ocean deposits is pumice stone.

Specimens of these stones, varying from the size of a pea to that of a foot-ball, have been taken in dredging at eighty of our stations. I have placed the position of these stations on a map, from which it will be seen that they occur all along our route.

Near volcanic centres the dredge has frequently brought them up in great numbers, as off the Azores in the Atlantic, off New Zealand and the Kermadec Islands, at several places among the Philippine Islands, off the coast of Japan, and elsewhere. As a rule, they are not numerous in shore deposits when these are distant from volcanic regions. In deposits far from land they are most abundant in deep sea clays, from which the shells and skeletons of surface organisms have been all or nearly all removed.

In the North Pacific the trawl brought up bushels of them from depths of 2,300 and 2,900 fathoms. Perhaps in no single instance have we trawled successfully on any of our deep sea clays without getting numbers of these stones. If there be an exception it is in the North Atlantic. But here it is to be remembered that while we were investigating the conditions of the North Atlantic, our attention had not yet been directed to the importance of detecting the presence of pumice, and we have not preserved such large samples of the North Atlantic deposits as those of other regions.

On the whole, pumice-stones are more numerous in the Pacific than in the Atlantic deposits.

In the Globigerina and other organic oozes, they are abundant or otherwise, according as the deposit is near or far removed from volcanoes. In these oozes they never occur so abundantly as in the clays. They are more or less masked and covered up by the accumulated remains of foraminifera, diatoms, or other surface organisms. In like manner they are obscured in shore deposits by river and coast detritus. Besides those specimens, which are sufficiently large to be examined by the hand, we detected with the microscope minute particles of feldspar in all our ocean deposits.

An inspection of the specimens which I have placed on the table will show that the majority of these pumice stones have a rolled appearance. Some of them have undergone much decom-

[1] "On the Distribution of Volcanic Débris over the Floor of the Ocean; its Character, Source, and some of the Products of its Disintegration and Decomposition," by Mr. John Murray. Read at the Royal Society, Edinburgh.

position, while others are little altered. Some are coated with the peroxide of manganese, or have streaks of this substance running through them. They are the most frequent nucleus of the manganese nodules, to which I shall presently refer. Some specimens which were dredged from a depth of over three miles, will, when dried, float for weeks in a basin of water; others, which have undergone partial decomposition, sink at once.

They present a great variety of texture and composition. They are white, grey, green, or black in colour. They are highly vesicular, or rather compact and fibrous. There would appear to be every gradation from common feldspathic to dark green pyroxenic kinds.

We find in them crystals of sanidin, augite, hornblende, olivine, quartz, lucite, magnetite, and titaniferous iron. Magnetic iron ore was found in all the specimens examined, either in crystals or in the form of dust. The other minerals vary in kind and abundance in the different specimens. The same crystals which we find in the pumice occur in all the kinds of ocean deposits.

Sources of the Pumice-Stones.

The pumice-stones which we find at the bottom of the sea have most likely all been formed in the air. Some of them may have fallen upon the sea; but the great majority seem to have fallen on land, and been subsequently washed and floated out to sea by rains and rivers. After floating about for a longer or shorter time they have become water-logged and have sunk to the bottom. Both in the North Atlantic and Pacific small pieces of pumice were several times taken on the surface of the ocean by means of the tow-net. Over the surface of some of these serpulæ and algæ were growing, and crystals of sanidin projected, or were imbedded in the feldspar. During our visit to Ascension there was a very heavy fall of rain, such as had not been experienced by the inhabitants for many years. For several days after many pieces of scoriæ, cinders, and the like were noticed floating about on the surface of the sea near the island. Such fragments may be transported to great distances by currents.

On the shores of Bermuda, where the rock is composed of blown calcareous sand, we picked up fragments of travelled volcanic rocks. The same observation was made by General Nelson at the Bahamas. Mr. Darwin noticed pieces of pumice on the shore of Patagonia, and Prof. L. Agassiz and his companions noticed them on the reefs of Brazil. During a recent eruption in Iceland, the ferry of a river is said to have been blocked for several days by the large quantity of pumice floating down the river and out to sea. All the pumice which we find need not be of quite recent origin. Mr. Bates informs me that great quantities of pumice are continually being floated down the Amazon. These come from near the foot of the Andes, where the head-waters cut their way through fields of pumice-stones. In the province of Wellington, New Zealand, two of the rivers run through areas covered with pumice, and during floods bear great quantities out to sea.

Prof. Alex. Agassiz has kindly furnished me with the following note:—

"The river Chile, which flows through Arequipa, Peru, has cut its way for some thirty miles through the extensive deposits of volcanic ashes which form the base of the extinct volcano, Misti. Some of the gorges are even 500 feet in depth, forming regular cañons. The whole length of the river bottom is covered by well-rolled pieces of pumice from the size of a walnut to that of a man's head. In the dry season (winter) there is but little water flowing, but in the summer, or rainy season, the river, which has a very considerable fall (7,000 feet in a distance of about ninety miles), drives down annually a large mass of these rolled pumice-stones to the Pacific. The volcanic ashes are not recent. There is no tradition among the Indians of any eruption within historic times."

Capt. Evans, the present hydrographer to the navy, informs me that he frequently picked up pumice on the Great Barrier Reef of Australia.

Volcanic Ashes.

Near volcanic centres, and sometimes at great distances from land, we find much volcanic matter in a very fine state of division at the bottom of the sea. This consists of minute particles of feldspar, hornblende, augite, olivine, magnetite, and other volcanic minerals. In the South Pacific, many hundred miles from land, and from a depth of 2,300 fathoms, the trawl brought up a number of pieces of tufa entirely composed of these comminuted fragments. These particles appear to me to have been carried to the areas, where we find them, by winds, in the form of what is known as volcanic dust or ashes. Sir Rawson Rawson sent to Sir Wyville Thomson a packet of the volcanic ashes which fell on the island of Barbadoes, after an eruption in 1812 on the island of St. Vincent, W.I., one hundred and sixty miles distant. I have examined this, and find it made up of fragments of the same character as those in the tufa to which I have just referred, some of the particles being perhaps a little larger. We have sometimes found this ash in considerable abundance mixed up with the shells in a globigerina ooze. In the deposits for hundreds of miles about the Sandwich Islands there are many fragments of pyroxenic lava, which I believe have been borne by the winds, either as ashes, or in the form of Pele's hair.

At Honolulu we were informed that threads of Pele's hair were picked up in the gardens there after an eruption of Kilauea, one hundred and eighty miles from the volcano. This Pele's hair bears along with it small crystals of olivine.

Obsidian and Lava Fragments.

Small pieces of obsidian and of feldspathic and basaltic lavas were frequently found in deposits near volcanic islands.

At two stations in the South Pacific, many hundred miles from land, we dredged pieces of this nature of considerable size larger than ordinary marbles. It is difficult to account for the transference of these fragments to the places where they were found. It is, however, in this region, and this alone, that it may be necessary to bring in a submarine eruption to account for the condition of things at the bottom.

A consideration of these observations, and the specimens which are laid on the table, will, I think, justify the conclusion that volcanic materials, either in the form of pumice-stones, ashes, or other fragments, are universally distributed in ocean deposits.

They have been found abundantly or otherwise in our dredgings, according as these have been near or far from volcanoes, or as there has been much or little river and coast detritus, or few or many remains of surface organisms in the deposits.

Some of the Products of the Decomposition of Volcanic Débris.

Clay.—Pure clay, as is well known, is a product of the decomposition of feldspar, and the clay which we find in ocean deposits appears to have had a similar origin.

In the deposits far from land the greater part of the clay originates, I believe, from the decomposition of the feldspar of fragmental volcanic material, which we have seen to be so universally distributed.

Pumice-stone is largely made up of feldspar, and from its areolar structure is peculiarly liable to decomposition. Being permeated by sea-water holding carbonic acid in solution, a part of the silica and the alkalies are carried away, water is taken up, and a hydrated silicate of alumina or clay results.

Like most clays our ocean clays contain many impurities, these last being as varied as the sources whence the materials of the deposits are derived.

Let us briefly enumerate the sources of these materials.

We have (1) the matters derived from the wear of coasts, and those brought to the sea by rivers, either in a state of suspension or solution. The material in suspension appears to be almost entirely deposited within two hundred miles of the land.

Where great rivers enter the sea, and where we have strong currents, as in the North Atlantic, some of the fine detritus may be carried to a greater distance, but its amount can never be very large. In oceans affected with floating ice we have land *débris* carried to a greater distance than above stated; for instance, we can detect such materials in the deposits of the North Atlantic as far south as the 40th parallel N., and in the South Pacific as far north as the 40th parallel S.

Some of the substances in solution, as carbonate of lime and silica, are extracted by animals and plants to form their shells and skeletons; these last, falling to the bottom, form a globigerina, a pteropod, a radiolarian, or a diatom ooze. We have also the bones of mammals and fish mixed up in different kinds of deposits. These, as well as animal and vegetable tissues, generally are a source of phosphates, fluorides, some oxides of iron, and possibly of other inorganic material.

Sir Wyville Thomson, early in the cruise, suggested that much of the inorganic material in deposits is derived from the source to which I have just alluded. Our subsequent observations have, I think, shown that originally Sir Wyville gave too much importance to this as a source of the materials in our deep deposits.

2. We have the dust of deserts, which is carried great distances by the winds, and which, falling upon the ocean, sinks to the bottom and adds to the depositions taking place. In the trade-wind regions of the North Atlantic we have a very red-coloured clay, in deep water, which is largely made up of dust from the Sahara. Such dust frequently falls in this region as what is called blood-rain.

3. We have the loose volcanic materials, which have been shown to be universally distributed as floating pumice, or as ashes carried by the wind.

This short review shows that the clay in shore deposits is chiefly derived from river and coast detritus. As we pass beyond about one hundred and fifty miles from the shores of a continent the character of the clayey matter changes. It loses its usual blue colour, and becomes reddish or brown, and particles of mica and rounded pieces of quartz give place to pumice, crystals of sanidin, augite, olivine, &c. All this goes, I think, to show that in deposits far from land the clay is chiefly derived from volcanic *débris*, though in the region of the North Atlantic trade-winds much of it may be derived from the feldspar in the dust of the Sahara.

The pumice which floats about on the surface of the sea must be continually weathering, and the clay which results and the crystals which it contains will fall to the bottom, mingling with the deposit which is in course of formation. In our purest globigerina ooze this clay and these crystals are present. If a few of the shells, say thirty foraminifera, are taken from such a deposit, and carefully washed, and then dissolved away with weak acid, a residue remains, which is red-brown or grey in colour, according to the region from which the ooze came. If the same number of shells be collected from the surface and dissolved away in the same manner, no perceptible residue is observed. The clayey matter would therefore seem to have infiltrated into the shells soon after they fell to the bottom.

I have already mentioned several instances of pumice-stones having been found on coral-reefs. Many more instances could be given. These stones, undergoing disintegration in these positions, add clay, crystals of augite, hornblende, magnetic iron ore, &c., to the limestones which the coral animals are building up.

I have found these crystals in the limestones and red earth of Bermuda, and in a specimen of the limestone from Jamaica.

This observation, it appears to me, points out that the red earth of Bermuda, Bahamas, Jamaica, and some other limestones, may originally have been largely derived from fragmental volcanic materials, which were carried to the limestone while yet in the course of formation. There are also small particles of the peroxide of manganese in the red earth of Bermuda.

(*To be continued.*)

CHEMISTRY AND TELEGRAPHY[1]

DISCLAIMING at the outset any pretensions which could be advanced in his behalf for the honour conferred upon him, Prof. Abel assumed that his advancement to the position of president was intended more as a recognition of the special importance of chemical science in its application to telegraphy. Proceeding upon this assumption he made chemical science the basis of his address, and went on to show the principal directions in which it bears importantly upon the work of the telegraph engineer.

No stronger evidence of the value attaching to a combination of chemical with electrical research need be sought for than that which is to be found in the labours of the late Dr. Matthiessen. His investigations into the causes of the differences in the resistance of various kinds of commercial copper were followed by most important results.

The series of experiments so carefully conducted by him showed the influence which the principal metalloids and metals known to be naturally associated with copper exerted upon the conducting power of the pure metal, and he afterwards determined the conducting power of important varieties of commercial copper, and thus rendered it possible to assign to their real causes the enormous differences in the value of various kinds of commercial copper as conductors of electricity. For instance, amongst the many facts established by Matthiessen's experiments was the important one that by no combination of any other metal or alloy was it possible to increase the conducting power of pure copper, but that, on the contrary, a most prejudicial effect was exerted upon it by the presence of some of the non-metallic elements—notably oxygen and arsenic—which are almost invariably to be found as impurities in the copper of commerce. It was these non-metallic impurities he found rather than the presence of any of the other metals which chiefly impaired the conductivity of copper, although both iron and tin exercised a deleterious influence. Thus, fixing the conductivity of pure galvano-plastic copper at 100, the addition of merely traces of arsenic reduced it to 60; while an addition of 5 per cent. brought it as low as 6·5; the existence, again, of 1·3 per cent. of tin in pure copper reduced its conductivity to 50·4, and with only 0·48 per cent. of iron present the conductivity fell to 36.

Specially interesting were the experiments made by Matthiessen to ascertain the cause of the good effects which had long before his day been observed to be produced upon the working qualities of refined copper by the addition of minute quantities of lead. The existence of 0·25 per cent. of lead in copper renders it so rotten that it cannot be drawn into wire; the presence of even so minute a trace as 0·1 per cent. unfits it for wire-drawing. Some special action must therefore take place during the melting of copper which would serve to account for the toughening and softening effects obtained by the addition of a small quantity of lead. The fact that the copper when subjected afterwards to a most careful analysis shows nothing but the merest traces of lead, would indicate that during the process of melting, the lead combines with and removes from the copper some impurity which would otherwise materially affect its toughness and ductility. The well-known affinity of lead for oxygen, combined with the fact that the presence of oxygen in copper beyond some narrow limit was known to affect its quality prejudicially, afforded good reasons for supposing that this impurity could be nothing else than oxygen, and this view, which was further supported by the beneficial influence of lead when employed in casting operations with copper and gun metal, received the strongest confirmation of its correctness from Matthiessen's experiments. Thus, the addition of 0·1 per cent. of lead to a sample of copper (the two being fused together in a current of carbonic acid), raised its conductivity from 87·25 to 93, and the amount of lead remaining in the metal after that was too minute to be detected. So with tin, the alloying of 1·3 per cent. of which with copper reduced, as has been already stated, its conductivity to 50·4; yet on melting the sample fused in contact with air with 0·1 per cent. of tin raised its conductivity to 94·55.

It was these investigations of Matthiessen which indicated to the wire manufacturer whence he could obtain or how best fulfil the conditions for the purity of a quality of copper, which would meet the requirements of a conductor whose size might be laid down by the telegraph engineer, whilst his researches into the preparation of alloys brought the most valuable aid to the B.A. Committee of 1861, in their determination of the standards of electrical resistance.

But it is not only in facilitating the selection of suitable materials for *conductors*, as well as in raising their quality as such that chemical science has brought important aid to the telegraph engineer; it has been most usefully applied in the investigation and determination of the materials most suitable as the *dielectrics* of telegraph cables, and it is in this direction that telegraphy may look in the future for the most valuable results from the labours of the chemist. Dr. Miller's investigations (instituted at the desire of the Submarine Telegraph Committee) into the causes of the decay of gutta-percha and india-rubber, confirmed the results which Hoffman had already communicated in 1860 to the Chemical Society and which Mr. Spiller had obtained some years afterwards. But Miller examines more in detail than either of his predecessors has done, into the changes which these gums undergo, and firmly established the fact that the alterations in their structure, resulting in the gradual destruction of their insulating powers, was due entirely to atmospheric influence, accelerated by the exposure of the material to light. He further pointed out that intermittent exposure to moisture, especially if solar light has access, rapidly destroys gutta-percha, whilst if kept continually immersed in water it remains unchanged for an indefinite period. He also showed that commercial gutta-percha contained, previous to any special exposure to oxidising influences, as much as 15 per cent. of resinous matter and a considerable amount of water (2·5 per cent.) mechanically diffused through it. Considerable improvements had doubtless been made since that date in the mechanical processes for preparing gutta-percha, but these

[1] Abstract of Address at the opening meeting of the Society of Telegraph Engineers, January 24, by the President, Prof. Abel, F.R.S.

do not appear to have been attended with similar improvements in the quality of the material as indicated by its chemical composition, for the highest quality of sheet gutta-percha which Prof. Abel himself had been able to find contained 12·7 per cent. of resinous matter and 5 per cent. of water. Much greater pains are no doubt taken to consolidate the material and express the water from the gutta-percha coatings of wire than in the manufacture of sheet gutta-percha. Nevertheless, that a considerable amount of inclosed water still remains is evidenced by the fact that in two samples of covered wire, submitted by the same manufacturers as lately as September and November last, the one contained 1·86 per cent., and the latter 3·97 per cent. of water. Little doubt now remains that the processes of "mastication" (to which gutta-percha is subjected for the removal of certain impurities and the production of a mechanically homogeneous material) favours oxidation, so that the destruction of some of the most valuable qualities of gutta-percha as an insulator depend upon the degree of completeness to which the mechanical impurities have been removed. An examination of *old* gutta-percha seems to show that, provided the material has been reduced to a compact condition, oxidation due to exposure to the air and light proceeds but slowly.

Dr. Miller also points out that mastication promoted the oxidation of *india-rubber*, and further experience has established the similarity of the two gums in this respect. The application of vulcanising to india-rubber was hailed as a most important step in submarine telegraphy; but although many chemists have made this same process of vulcanising a subject for study and investigation, it remains imperfectly understood even to the present day. The wire manufacturer had no difficulty in meeting the most important objection urged against the application of the vulcanising process (viz., the injury done to the conductor by the chemical action of the sulphur in the dielectric upon it) by availing himself of the fact that tin would not be equally affected, and so protecting the copper by the simple process of tinning. Still the tendency to an alteration, either in the chemical or mechanical structure of vulcanised india-rubber, exhibited by it when kept submerged in water, has developed serious elements of uncertainty in cables prepared by the vulcanising processes. Prof. Abel then proceeded to give some interesting illustrations drawn from his own personal experience of the uncertainty of our existing knowledge regarding the chemical and other conditions to be fulfilled in the application of vulcanising processes to the preparation of telegraph cables.

A number of half-mile lengths, for instance, of vulcanised telegraph cable—some for field service, others for firing broadsides on board ship—were found, after a period varying from eighteen months to three years, to have undergone considerable deterioration; the dielectric in some instances had become so porous that even the variations in the hygroscopic condition of the atmosphere on board ship, where the wires were placed between decks, caused decided differences in the results obtained with a particular battery power; and this alteration was not distributed uniformly over a length, the porosity in some instances extending along a few feet only, the adjacent portions being in very good condition; an inspection of a large quantity of the same sort of cable which had remained untouched in store showed precisely similar results.

The uncertainty attaching to this is still further illustrated by the fact that in armoured cables with multiple cores of this description some of the cores remain comparatively good, whilst the insulation of others had fallen off to a very great extent.

Scarcely less conflicting is the experience gained with cables prepared according to Hooper's system. This system consists in maintaining the inner portion of the india-rubber surrounding the conductor in an unvulcanised condition by means of a "separator," which contains a preparation of a metal possessing the power of arresting the passage of the sulphur beyond it during and subsequent to the application of the vulcanising process.

The deterioration due to the alteration of the india-rubber being caused by oxidation, the question naturally arises as to how the oxygen finds access to it? It must evidently find access to the interior of the dielectric *through the substance of the cable*—a view which is more than confirmed by the researches of Graham. That eminent chemist showed that solid india-rubber absorbed oxygen to an extent which showed the gas to be twice as soluble in it as in water at the ordinary temperature, and the comparatively greater priority of vulcanised india-rubber would favour this absorption. The oxidation of unvulcanised india-rubber being once established, the tendency to the absorption of oxygen by the external vulcanised india-rubber, and to its passage through the latter, must be promoted by the increased tendency to chemical change of and continual assimilation of oxygen by the inner portion, which thus acts like the vacuum by which Graham caused air very rich in oxygen to filter through a stout vulcanised india-rubber tube.

The efforts made from time to time to improve the insulation of cables, served until lately to clear the ground for future experiments, but of late important success seems to have been achieved in a direction where different experimenters (including Prof. Abel himself) had failed—that direction is towards paraffin, "a substance which during the last thirty years had passed from the obscure position of a chemical curiosity to the foremost rank amongst important chemical products." In 1875 Mr. Field, F.R.S., working in conjunction with Mr. Talling, the mineralogist, produced by means of a solvent, or by masticating the substances together, a black ozokerit-product with india-rubber, which appeared quite free from the brittleness which Matthiessen, who also had been at work here, failed to get rid of. This preparation in point of insulation and inductive capacity compares very favourably with india-rubber and gutta-percha, and would seem likely to prove very valuable for telegraphic purposes in the future.

Prof. Abel could only allude to the importance of chemical science in the proper management of batteries, a subject which, after the valuable paper read before the Society by Mr. Sivewright, "On Batteries and their Employment in Telegraphy," and the instructive discussions which it elicited, needed only to be named. Amongst other matters of importance where the telegraph engineer might derive great benefit from the fruits of applied chemistry, were the decay and preservation of telegraph poles, the preservation of fibrous materials used in constructing submarine cables, the production of points and the protection of cables against the deposition of vegetable or animal growth.

Prof. Abel then concluded his address by a final illustration of the manner in which the practical electrician may unexpectedly be brought face to face with problems which can be solved by a knowledge of chemistry and by that alone. Lieut.-Col. Stotherd, R.E., having pointed out certain defects in the permanency and difficulties connected with the testing of Abel's "phosphide" fuse, he (Prof. Abel) constructed another form of high tension fuse specially designed for submarine mining. The poles of this new fuse were 0·05 of an inch apart, in an insulating column consisting of Portland cement with sufficient sulphur to allow of its being melted and cast in a mould. Fuses manufactured in this way were supplied to different military stations, and after a time it was found that the average resistance of the fuses being 15,000 ohms, that of many of them had fallen as low as 300 or 400 ohms, and one or two had gone down even below 50 ohms. The cause of this at first sight inexplicable change in the stability of the fuse was traced by Mr. E. O. Brown to the existence in many of the cement pillars of very minute hair-line cracks or fissures extending sometimes right across the space between the inclosed small copper wires. The sulphur in the cement and the copper wire in presence of the air which had penetrated with the ever-concomitant moisture had set up a galvanic action which had formed one or more complete bridges, thereby short-circuiting the copper poles. Chemical knowledge, which unravelled this mystery at once, provided the remedy; platinum, upon which sulphur and air were powerless, replaced the copper, and the permanence of the fuse was secured.

A hearty vote of thanks to Prof. Abel was carried by acclamation, and it was decided that the address should be printed and circulated amongst the members.

SCHOLARSHIPS AND EXHIBITIONS FOR NATURAL SCIENCE AT CAMBRIDGE, 1877

THE following is a list of the Scholarships and Exhibitions for proficiency in Natural Science to be offered at the several Colleges and for Non-Collegiate Students in Cambridge during the present year:—

Trinity College.—One or more Foundation Scholarships of 100*l.*, and one Exhibition of 50*l.* The examination for these will commence in the first week of April.

St. John's College.—One of the value of 50*l.* per annum. There is a separate examination in Natural Science at the time of the annual College examination at the end of the academical year, in May; and Exhibitions and Foundation Scholarships ranging in value up to 100*l.* will be awarded to students who show an amount of knowledge equivalent to that which in Classics or Mathematics usually gains an Exhibition or Scholarship in the College.

King's College.—On Wednesday, April 4, 1877, and following days an Exhibition in Natural Science will be offered for competition. The Exhibition is worth about 90*l.* a year, and is tenable for three years, but not with any other Exhibition or Scholarship of the College.

Christ's College.—One or more in value from 30*l.* to 70*l.*, according to the number and merits of the candidates, tenable for three-and-a-half years, and for three years longer by those who reside during that period at the College.

Gonville and Caius College.—One of the value of 60*l.* per annum. The examination begins on the last Tuesday in the Lent term. College examinations are held annually in the Easter term for Medical and Natural Science Students who have passed the University previous examination, in Anatomy, Physiology, Physics, Chemistry, &c., at which prizes and Scholarships of the value of from 60*l.* to 20*l.* are awarded to members of the College of the first, second, and third year, on precisely the same conditions as those for other branches of learning. Examinations are also held, as vacancies occur, in Botany and Comparative Anatomy in its most general sense (including Zootomy and Comparative Physiology), for two Shuttleworth Scholarships, each of the value of 60*l.* per annum, and tenable for three years. The successful candidates for the Tancred Medical Studentships are required to enter at this College; these studentships are five in number, and the annual value of each is 100*l.* Information respecting these may be obtained from B. J. L. Frere, Esq., 28, Lincoln's Inn Fields, London.

Clare College.—One of the value of 60*l.* per annum, tenable for two years at least. The examination will be held on March 20.

Downing College.—One or more of the value of 60*l.* per annum. The examination will be on or about April 9.

Sidney College.—One of the value of 60*l.* The examination will be on March 20.

Emmanuel College.—One Foundation Scholarship of 70*l.*, tenable till the holder is of standing for the degree of B.A., and four Minor Scholarships (two of 70*l.*, and two of 50*l.*), tenable for two years, will be awarded. The examination will take place on March 20.

Non-Collegiate Students.—An Exhibition each year is given by the Clothworkers' Company, value 50*l.* per annum, tenable for three years. Examination about Christmas, open to Non-Collegiate Students who have commenced residence in the October term, and to any who have not commenced residence. Information to be obtained from the Rev. R. B. Somerset, Cambridge.

The subjects, it may be stated generally, are Chemistry, Physics, Geology and Mineralogy, Botany, Comparative Anatomy and Zoology, and Physiology; but for detailed information application must be made to the tutors of the respective Colleges.

Although several subjects for examination are in each instance given, this is rather to afford the option of one or more to the candidates, than to induce them to present a superficial knowledge of several. Indeed, it is expressly stated by some of the Colleges that good clear knowledge of one or two subjects will be more esteemed than a general knowledge of several. In some instances, as at Caius College, each candidate is required to furnish beforehand a list of the subjects in which he desires to be examined.

There is no restriction on the ground of religious denominations in the case of these or any of the Scholarships or Exhibitions in the Colleges or in the University.

Some of the Colleges do not restrict themselves to the number of Scholarships here mentioned, but will give additional Scholarships if candidates of superior merits present themselves; and other Colleges than those here mentioned, though they do not offer Scholarships, are in the habit of rewarding deserving students of Natural Science.

It may be added that Trinity College will give a Fellowship for Natural Science, once, at least, in three years, and that such a Fellowship will be given in the present year. The examination will take place at the end of September, and will be open to all Bachelors of Arts, Law, and Medicine of the University, of not more than three years' standing from their first degree. Application should be made to the Rev. Coutts Trotter, Tutor of Trinity. Most of the Colleges are understood to be willing to award Fellowships for merit in Natural Science equivalent to that for which they are in the habit of giving them for Classics and Mathematics.

OUR ASTRONOMICAL COLUMN

THE COMET OF 1812.—In view of the approaching return of the comet discovered by Pons on July 20, 1812, which beyond doubt, at the time of its visibility, was moving in an elliptic orbit with a period of about seventy years, it is not without interest to inquire into the particular circumstances of its track in the heavens, and distance from the earth and sun, under different assumptions, with regard to the time of the next perihelion passage. The case is a very different one to that of Halley's comet (which has a period only five or six years longer than that of the comet in question) at its last appearance in 1835, or even at the previous one in 1759. The semi-axis major of Halley's comet was already known with considerable precision, from this body having been observed at several returns to perihelion since the year 1456, and in 1835 an exceedingly close prediction of the date of the comet's arrival at its least distance from the sun was made, it is true, after most laborious calculation. Pons' comet of 1812 is not thus situated. So far, no previous appearance has been recognised, and we are, therefore, dependent entirely upon the observations made in 1812 for the determination of the length of the revolution, and hence of the epoch of its next return. Within what limits these observations admit of the period being assigned, has not perhaps as yet been fully examined, but it appears probable they will be wider than in the case of another comet of similar length of revolution, that discovered by Olbers on March 6, 1815, the perturbations of which were calculated for the present revolution by Bessel, who fixes the return to February, 1887, though the prediction may be materially in error.

From the great inclination of the orbit of Pons' comet to the plane of the earth's annual path, it is perhaps possible that with a fairly accurate prediction of its position, it might be detected with very powerful telescopes, no matter at what time of the year the perihelion passage falls, but such prediction being impracticable, it is desirable, as we have already remarked, to trace out the apparent path of the comet amongst the stars, on different hypotheses as to date of arrival at perihelion. At present we shall confine our remarks to the more favourable conditions under which it is possible for the comet to appear.

The nearest approach of the comet's orbit to that of the earth (0·185) occurs near the passage of the descending node, about $9\frac{3}{4}$ days before the arrival at perihelion, and the longitude of the descending node being in 73° 56′ for 1880, we may assume the perihelion passage to take place on December 15·0. In this case the comet would have the following track:—

	R.A.	N.P.D.	Distance from earth.
	°	°	
Nov. 5	223·8	32·9	0·787
,, 15	228·4	38·3	0·551
,, 25	236·3	52·7	0·316
Dec. 5	252·5	110·1	0·185
,, 15	283·0	157·0	0·356
,, 25	311·4	164·8	0·629

If the perihelion passage be taken eight days later, when the earth and comet would have about the same heliocentric longitude, with the latter body in perihelion, we shall have:—

	R.A.	N.P.D.	Distance from earth.
	°	°	
Oct. 24	231·3	29·6	1·181
Nov. 13	241·8	34·7	0·760
,, 23	251·4	40·1	0·529
Dec. 3	267·8	56·4	0·308
,, 13	293·9	110·7	0·223
,, 23	320·9	146·2	0·396
Jan. 2	336·9	155·8	0·656

Under such conditions it appears very improbable that the comet could escape observation. At its discovery in 1812 it was a diffused telescopic nebulosity, but towards the end of August it became visible to the unaided eye, and about the time of nearest approach to the earth in the middle of September it exhibited a tail $2\frac{1}{4}°$ in length, according to Baron de Zach; at this period, though near perihelion, its distance from the earth was 1·26. We may conclude that should the comet arrive at its least distance from the sun about the close of the year, its recovery will be almost certain.

In a future note we shall examine the conditions attending perihelion passage at other seasons.

The appearance immediately preceding that of 1812 probably occurred about the year 1742. The calculated comet of that year had very different elements, and the same remark applies to the two comets of 1743. Struyck mentions a second comet in 1742, recorded in the journals of several Dutch navigators. On the morning of April 14, the ship being (at noon) in latitude 35° 36′ S., and longitude 42° E., the comet was in the E. ¼ S.E., with a tail 30° in length; the time is not given. From this rough indication it may perhaps be inferred that its place was somewhere amongst the stars of Pisces, or bordering ones in Aries; in too small a right ascension to admit of its identity with the comet of 1812. And as already stated, an examination of earlier cometary records is not attended with more success.

During the actual revolution there may be very sensible perturbations due to the attraction of the planet Uranus.

THE ZODIACAL LIGHT.—This phenomenon was conspicuous in the neighbourhood of London on the evening of the 4th inst. At 6h. 35m. the light was very much stronger than that of the Via Lactea in the brightest part above the horizon, and totally different in colour, being a pale yellow in the more elevated portion, with a ruddy tinge nearer the horizon. It was not distinctly traceable much beyond ζ Piscium; the axis of the light passed through about R.A. 352°, N.P.D. 100°.

BIOLOGICAL NOTES

AMOUNT OF WATER IN TREES.—Farmers and gardeners have often observed, and the fact is referred to by Lindley, that during cold weather the branches of certain trees are sometimes so much bent down as to obstruct passage below the tree, but that with the advent of mild weather they return to their former positions. In investigating these phenomena, Prof. Geleznow observed that they depend not only upon temperature, but also upon the humidity of the air; and he undertook, therefore, a series of researches to ascertain the amount of water contained in different parts of the branches under various atmospheric conditions. The first part of these researches (not yet published) proved (1) that the amount of water increases in each branch from its base to its summit; (2) that the bark of the larch throughout the year contains more water than the wood; and (3) that in Coniferæ the upper part, *i.e.*, the part above the pith of a horizontal branch, contains always more water than the lower part, whilst in other trees, as, for instance, the birch, the conditions are reversed; altogether, that Coniferæ and Dicotyledones seem to possess opposite properties, as regards the distribution of water in the tree. Further researches, published now in full (*Bull. Ac. de St. Pétersb.*, vol. xxii., No. 3), introduced new elements into the inquiry, namely, the varying amount of water in the bark and the wood. It appears from these researches that humidity of the wood and dryness of bark have a constant relation; that in certain trees (fir and maple) the wood remains throughout the year drier than the bark, while in others (birch and aspen) this is the case only during a part of the year, the conditions being reversed at other times. The relations between the humidity of the bark and that of the wood are so constant, that a useful classification could be based on them. It appears, further, that the smallest amount of water contained by the branches of certain trees, as, for instance, the fir, is observed during the season when the vegetation is in fullest vigour, and that this circumstance, as well as some other important facts, is in close relation with the development of leaves. Altogether the researches, which are yet far from being completed, promise to disclose, and probably explain, a variety of very interesting facts.

THE EEL.—In the last session of the Rhenish and Westphalian Natural History Society, O. Melsheimer reported the results of observations on the habits of the eel, conducted through a series of years. The statement that the eel subsists on vegetable nourishment, probably originating from Albertus Magnus, is shown to be utterly false. Examinations of the contents of the stomach of numerous individuals show that the food of the eel is exclusively animal. It seems to be especially fond of the river lamprey (*Petromyzon fluviatilis*). The periodical movements—down stream in August and September, and up stream in April—are brought in connection with the spawning, which takes place in the sea. The bluish-black and the yellowish-green varieties are perfectly alike in their habits.

HONEYDEW IN PLANTS.—Prof. Dr. H. Hoffmann, of Giessen, has recently published the results of his observations on the formation of honeydew upon the leaves of plants, and has come to the conclusion that it is not to be attributed to the *Aphis*, or other insects. A healthy specimen of *Camellia japonica*, 1½ feet in height, without blossoms, which afforded an instance of the phenomenon, was found to be entirely free from insects. The so-called honeydew consisted of a sticky colourless liquid, which possessed a sweetish taste, and contained, principally, gum. This gradually appeared on the surface of the leaves, slowly forming drops on the under-side, which dropped down to be continually replaced. The separation of the liquid continued vigorously for some time, even after the removal of the leaves from the plant. Although showing that the appearance of the dew is not attributable to insects, Prof. Hoffmann was unable to ascertain the real method of formation. On the upper side he was able to trace the origin of spots of a clear slightly sweet liquid on the leaves of an ivy, to the presence of *Coccus sp.* This insect, as well as *Coccus abietis* and *pini*, seems to possess the power of forcibly ejecting, *per anum*, a sweetish secretion, which causes them to be sought after by bees.

RELATION OF BODY-CHANGE TO TEMPERATURE.—From exact experiments on frogs (measuring the consumption of oxygen and production of carbonic acid at different temperatures), M. Schulz arrives at the conclusion that the exchange of materials in these animals is directly dependent on the temperature (Pflüger's *Archiv*). It is specially notable, in M. Schulz's tables, that at 1° body-temperature the frog exhales so little carbonic acid that it was hardly certain whether it produced any (the amount was 0·0084 gr. per kilo. and hour). At 33° to 35°, on the other hand, the frog shows an exchange of material which comes up to that of man, and at 37° it would probably exceed this considerably, if the organism of the cold-blooded animal permitted of so rapid a replacement as the strong consumption would require. The upper limit of temperature for the frog is therefore somewhere about 35° C.

NOTES

THE city of Brunswick is making preparations to celebrate the 100th birthday of Carl Friedrich Gauss, the mathematician and astronomer, who was born there April 30, 1777. A statue is to be erected to Gauss, and it is hoped that the foundation stone will be laid on the celebration day. Contributions are requested by the Committee to be sent to the Brunswick Bank.

FROM a circular recently issued by the general committee intrusted with the duty of collecting subscriptions for the erection of a statue to Liebig, it appears that the sum total contributed up to January 1, 1877, amounts to over 7,000*l.*, after the deduction of necessary expenses. Russia contributed over one-half of the receipts acknowledged in this third and last report. Since the decision to provide Giessen as well as Munich with a statue, the authorities of the former place have selected a fitting locality for the memorial, and laid it out in a tasteful manner.

WE greatly regret to hear of the death of Capt. J. E. Davis, in his sixty-first year. Capt. Davis had only recently retired from the Hydrographical Department, to which he had rendered important services. He was also well known as an authority on polar matters, having himself seen service in the Antarctic regions. Capt. Davis had much to do in connection with the fitting out of the *Challenger* Expedition, and had himself made important contributions to hydrography.

LETTERS from Athens report the death of Prof. J. Papadakis, the Rector of the University, after a long period of suffering. He occupied the chair of mathematics and astronomy during a long series of years, and was a leading spirit not only in scientific circles, but also in the general society of Athens.

THE question of the erection of a great polytechnic school in Berlin is to be brought before the German Parliament. The estimated cost is eleven million marks.

THE philosophical faculty of Zürich University has conferred the degree of Doctor in Philosophy on a lady.

IN our notice last week of "Two *Challenger* Books," it was inadvertently implied that Lord George Campbell's "Log Letters from the *Challenger*," did not contain a map. That work has a map and an excellent one, taken, in fact, from the *Proceedings* of the Royal Society. Not only does it show the course of the ship, but the depths and dates of the various soundings, and by means of different colours, the varied deposits found on the ocean bed. The map adds greatly to the scientific value of the work.

M. BECQUEREL will take for the subject ot his lectures at the Paris Museum, Light and its Effects. The course of lectures will begin after Easter, and include the subject of the radiometer. Neither of the two Becquerels, for M. Leon Becquerel is his father's assistant, has ever given his opinion on the radiometer, and their joint verdict is expected with not a little curiosity.

NINE Lectures on the Osteology of Birds will be delivered in the theatre of the Royal College of Surgeons, on Mondays, Wednesdays, and Fridays, at 4 P.M., commencing on Friday, February 16, 1877, by Prof. W. K. Parker, F.R.S.

A NEW mercury rheostat, which Jacobi devised shortly before his death, is described by M. Chwolson (*Bull. Ac. de St. Pétersb.*, vol. xxii. p. 409), and its advantages and disadvantages are thoroughly discussed and illustrated by the results of some measurements. Owing to the very great precision of the new instrument, it appears to be especially useful for the measurement of very small resistances. The author concludes that this rheostat leaves far behind all former ones, and that the instrument itself, or at least its principles, will probably play an important part in future galvanometric researches.

THE Smith's prizes, Cambridge, have been adjudged as follows:—First prize, Donald MacAlister, B.A., St. John's College; second prize divided between Richard Charles Rowe, B.A., of Trinity, and James Parker Smith, B.A., of Trinity. Mr. MacAlister was senior wrangler, and Mr. Rowe and Mr. J. P. Smith third and fourth wranglers in this year's tripos.

AT a meeting of the Council of the Yorkshire College of Science, held February 2, it was resolved, "That the question of an extension of the curriculum in the direction of literature is now ripe for action on the part of the College," and a committee was appointed to confer with a delegation from the University Extension Committee, in order that a scheme might be brought before the Board of Governors. This is a step in the right direction.

THE United States Government have awarded Capt. Allen 800 dollars, and Capts. Adams, Soutar, and Walker, 300 dollars, for their kindness to the crew of the Arctic ship *Polaris*.

THE *Journal* of the Anthropological Institute will in future appear on the 1st of February, May, August, and November.

THERE will be an examination at King's College, Cambridge, on April 4 and following days, for an exhibition in natural science. The exhibition is worth about 90*l.* a year, tenable for three years, but not with any other exhibition or any scholarship of the college. Candidates must be under twenty years of age, unless already members of the college. The examination will be in physics, chemistry, and either comparative anatomy or botany, in addition to elementary classical and mathematical papers. Candidates must give a fortnight's notice of their intention to compete, sending in to the tutor certificates of character, and naming the particular subjects in which they wish to be examined.

THE following College Lectures in the Natural Sciences will be given at Cambridge during Lent Term:—Gonville and Caius College: "On the Physiology of Digestion, Absorption, and Sanguification," by Dr. Bradbury; "On Non-metallic Elements," by Mr. Apjohn. Christ's College: "On Vegetable Histology," by Mr. Vines. St. John's College: "On Chemistry," by Mr. Main; instruction in Practical Chemistry will also be given; "On Physical Geology," by Mr. Bonney; "On Palæontology," by Mr. Bonney; in the course of the term some demonstrations in Microscopic Lithology will be given; elementary course in Geology postponed to next term. Trinity College: "On Electricity," by Mr. Trotter; "Elementary Physics," by Mr. Trotter; "An Elementary Course of Practical Morphology," by Mr. Balfour; "Practical Physiology and Histology," by the Trinity Prælector in Physiology (Dr. Michael Foster), at the New Museums. Sidney Sussex College: "On Vegetable Histology and Physiology," by Mr. Hicks. Downing College: "On Chemistry," by Mr. Lewis; "On Comparative Anatomy and Physiology," by Mr. Saunders.

THE Bessemer Medal of the Iron and Steel Institute has been awarded to Dr. Percy, F.R.S.

THE King of Greece has conferred upon Mr. Edward Stanford the knighthood of the Royal Order of the Saviour for the services rendered by him to geographical science.

A BILL has been proposed to the U.S. Congress for the equipment of several Arctic expeditions.

THE sad news has been received from the African West Coast, that Baron Barth committed suicide, under an attack of fever, at Loanda, on December 7, 1876, and Dr. Mohr died at Malange on November 26, 1876, where he had only recently arrived. Baron Barth was making a botanical and geological survey of Portuguese Africa on account of the Portuguese government. Dr. Mohr will be known to our readers as the author of an interesting narrative of his journey to the Victoria Falls of the Zambesi; he was sent out by the German African Society to carry on the work of exploration from the Portuguese colony from which so many German explorers have had to return.

A FRENCH expedition under MM. Brazza and Marche is exploring the Ogowe, a large stream to the north of the Congo. News has been received by the Geographical Society of Paris from these explorers, said to be important, and will be made public at the next sitting.

THE recent discussion of the budget in the Belgian House of Representatives brought out some interesting information as to the state of primary instruction in the country. The general yearly expenses of the State for educational purposes being, in the average of many years, about 480,000*l*. (6 per cent. of the whole of the budget), from two-fifths to one-half of this sum was devoted to primary instruction. The ordinary allotments of the State for this subject were, during the years 1872 to 1876, from 188,000*l*. to 244,000*l*.; but the part taken by the communes in primary instruction is very limited. When compared for instance, with Germany, the share of these expenses which falls on the State, is as much as about 38 per cent. of the whole of the expenses of the country. The number of normal schools for primary instruction was thirty-nine, for a population of 5,250,000 souls, *i.e.*, one normal school for every 141,970 inhabitants. But the instruction, and yet more the inspection, remain still mostly in the hands of the Catholic clergy, and the general results of the efforts made by the State, though showing some improvement during the last ten years, are by no means satisfactory. Steps are being taken to introduce the teaching of natural science into primary schools. Thus, M. Couvreur ably advocated in the House the foundation of a central and some local pedagogical museums, on the plan of that of St. Petersburg, which museums would be permanent exhibitions of recent improvements made in Europe and America in the elementary teaching of natural science; he also recommended institutions where the value of the various methods and apparatus could be submitted to experiment and discussion. Such a museum is to be opened before long by the city of Brussels. The Ministry also recommends to teachers to give to their scholars some elementary notions in natural science, applied to agriculture.

THE first number of Petermann's *Mittheilungen* for 1877 contains several papers of much value. There is the first instalment of a paper on the ethnology of Russia, in which this question is gone into with the usual thoroughness, accuracy, and detail of this journal; it is accompanied by a carefully-constructed map, embracing the whole of Russia in Europe and Asia, as well as some of the neighbouring territories. Dr. Loesche describes the results of a journey by himself and Dr. Falkenstein, in 1875, up the Killoo or Kuilu river, in Loango; he gives some important notes on the natural history of the district. E. Tessier gives a *résumé* of M. J. Dupuis' travels in South China, and Dr. A. Mühry discusses the geographical conditions of some European storms. In a short paper we are informed that Clemens Denhardt has been making preparations for some time for an exploring expedition into Central Africa, the particular region which he intends to occupy being that bounded by the Indian Ocean, the east and south of the Abyssinian Mountains, the Nile and its tributaries, the great lakes, Kilimanjaro and the River Dana—a region still almost entirely unknown. A feature of great interest and the highest importance has been commenced in this number, viz., a monthly summary of geographical work in the various regions of the globe, by Dr. Behm. The first instalment embraces the last three months of 1876, and its regular continuance will make the *Mittheilungen* almost all that could be desired as a geographical journal.

M. FOUQUÉ has been appointed professor to the College of France, in room of the late M. Charles St. Claire-Deville, whose pupil and assistant he was.

AT the next meeting of the Society of Telegraph Engineers, to be held on the evening of Wednesday the 14th inst., Mr. W. H. Preece will read a paper on "Shunts and their Applications to Electrometric and Telegraphic Purposes."

WE have received the first number of a new monthly popular Norwegian scientific journal named after our own, *Naturen*. The editor is Hans H. Reusch, and among the list of contributors is the well-known name of Prof. Sars.

PROF. DE BARY, of Strassburg, has declined the offer of the Botanical Chair in Tübingen rendered vacant by the death of Prof. Hofmeister.

DR. HENRY MUIRHEAD, of Cambuslang, has offered to the University of Glasgow the sum of 2,100*l*. as an endowment for a Demonstrator of Physiology in connection with the Chair of the Institutes of Medicine. The object of the endowment is the promotion of medical science by the training of young men of suitable capacity to become teachers and investigators of physiology, and as this training is best attained by actual work in the laboratory and by practical experience in the art of teaching, the demonstrator will be regarded as a teaching assistant to the professor, while he will also be encouraged to pursue independent original investigation, and will be aided by the use of all the laboratory appliances.

THE third edition of "L'Homme Fossile en Europe," by the late H. Le Hon, being out of print, a fourth edition, just appeared in Brussels, will be the more welcomed as it contains, besides a short biography of the author, numerous additions by M. Ed. Dupont, referring to the recent discoveries in this department, and bringing this most valuable work to the present level of our knowledge as to the origin of man.

WE are glad to see that a second edition of Dr. Frank Clowes's "Elementary Treatise on Practical Chemistry" (J. and A. Churchill) has been published, with some useful additions. We noticed the first edition in vol. xi. p. 107.

IN the *South Australian Register*, of November 28, 1876, is an interesting lecture by the Rev. S. J. Whitmee, on the Ethnology and Philology of Polynesia. He contends that over all Polynesia there are two distinct types of people, a brown race connected with the Malays, and a black, or negro race, connected with the Papuans. There is also a third and very much mixed race, to which Mr. Whitmee could not venture to give a name or assign an origin.

WE have received a separate reprint from the *Philosophical Magazine*, of Capt. Abney's paper "On the Alkaline Development of the Photographic Image."

PROF. DIETERICI, of Berlin, sought to show in a public lecture, delivered a few days since, that the theories of Darwin were by no means novel, having been essentially published by learned Arabs in the tenth century.

WE have received several numbers of the *Bulletin* of the Torrey Botanical Club of New York, containing interesting papers which relate chiefly to botanical subjects of local interest.

THE additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Dr. Broadbent; a Brazilian Tree Porcupine (*Cercolabes prehensilis*) from Trinidad, presented by Mr. Eliot S. Currey; three Amherst Pheasants (*Thaumalea amherstiæ*) from China, presented by Dr. A. P. Reid; a Yellow-fronted Amazon (*Chrysotis ochrocephala*) from U. S. Columbia, presented by Mr. F. A. B. Geneste; three Rhomb-marked Snakes (*Psammophylax rhombeatus*) from South Africa, presented by the Rev. P. H. R. Fisk; an Ocelot (*Felis pardalis*) from South America, three Andrean Geese (*Bernicla melanoptera*) from Peru, purchased; two Double-striped Thicknees (*Œdicnemus bistriatus*) from Central America, purchased.

SOCIETIES AND ACADEMIES

London

Royal Society, January 25.—"Description of the Living and Extinct Races of Gigantic Land Tortoises, Parts iii. and iv. The Races of the Aldabra Group and Mascarene Islands" (conclusion), by Dr. Albert Günther, F.R.S.

In continuation of, and concluding, the researches into the history of the Gigantic Land-Tortoises, read before the Royal Society on June 20, 1874, and published in the 165th volume of the "Philosophical Transactions," the author treats in Parts iii. and iv. of the Tortoises of the Aldabra Group and Mascarenes.

By the addition of the valuable materials obtained by one of the naturalists of the Transit of Venus Expedition to Rodriguez, and by the Hon. Edward Newton in Mauritius, as well as by the aid of supplementary information received from other sources, the author has been enabled to show in the present parts of his paper that the round-headed division of Tortoises is confined to Aldabra and never extended to the Mascarenes proper; and that the Tortoises from the latter islands can be externally, though not osteologically, distinguished *as a whole* from the Galapagos Tortoises, as will be seen from the following synopsis:—

Nuchal plate absent. Frontal portion of the skull flat. Fourth cervical vertebra biconvex. Pelvis with broad symphysial bridge.

A. Gular plate double; sternum of moderate extent ... ... GALAPAGOS TORTOISES.

B. Gular plate single; sternum short ... . MASCARENE TORTOISES.

a. Carapace thin, thickened towards the margins; centre of the last vertebral plate raised into a hump, which is separated from the penultimate vertebral by a transverse depression: *Tortoises of Mauritius* (*T. triserrata*, *T. inepta*, *T. indica*, *T. leptocnemis*).

b. The entire carapace extremely thin and fragile, all the bones very slender: *Tortoise of Rodriguez* (*T. vosmæri*).

II. Nuchal plate present. Frontal portion of the skull convex. Third cervical vertebra biconvex. Pelvis with narrow symphysial bridge. Gular plate double. Carapace thick. ALDABRA TORTOISES (*T. elephantina*, *T. daudinii*, *T. ponderosa*, *T. hololissa*).

Linnean Society, January 18.—Prof. Allman, president, in the chair.—Three new Fellows were elected, viz., Dr. W. Miller Ord, Thos. Routledge, and S. D. Titmas.—An interesting and scientific memento of the ill-fated *Polaris* Expedition was exhibited by Mr. R. Irwin Lynch. This consisted of a pot of growing wheat which had been sown from the grain left in Polaris Bay, 81° 38′ N., by the American Expedition. Capt. Sir George Nares, in a letter to Dr. Hooker, says that the grain in question had been exposed to the winter frosts, 1872-76; notwithstanding the intense cold it had been subjected to, the above sample grown at Kew gave 64 per cent. as capable of germination. A grain of maize, among the wheat, which also sprouted, possessed even greater interest, inasmuch as being a truly tropical plant.—The amphibious and migratory fishes of India formed the subject of a paper by Dr. Francis Day. He first instanced many forms which respire air direct, can live for long periods after their removal from water, and are but little affected by a bandage being placed round their gills, preventing the use of that organ. The *Saccobranchus* was shown to have a distinctly amphibious circulation, venous blood being sent by the pulmonary artery to the respiratory sac, and arterial blood being returned from it to the aorta. He questioned the accuracy of the swim-bladder of fishes, being the homologue of the respiratory bladder of amphibia, and observed that in the *Saccobranchus* both a respiratory sac and a swim-bladder co-existed; the one along the muscles of the back, the other more or less inclosed in bone but possessing a pneumatic duct.—Mr. G. J. Romanes read a second notice on varieties and monstrous forms of Medusæ. He expressed surprise that among the jelly fish—at least the naked-eyed group, with their lowly grade of organisation and proneness to exhibit the phenomena of gemmation—examples of monstrous and misshapen forms are comparatively rare. In those cases met with, especially in *Aurelia aurita*, the deviations from the normal type nearly always occur in a multiplication or in an abortion or suppression of *entire segments*. This affects the segments of the umbrella in a symmetrical manner, whilst the ovaries and manubrium, to a certain extent, may or may not be implicated.

Chemical Society, February 1.—Prof. Abel, F.R.S., president, in the chair.—Dr. H. E. Armstrong read a paper on Kekulé's and Ladenburg's benzene symbols, in which he discussed the relative value of the two symbols as a means of expressing the known reactions of benzene and its derivatives, expressly pointing out how Ladenburg's prism symbol was more in accordance with our knowledge of the quinones; but that up to the present time, although it might be considered proved that in benzene six carbon atoms were linked together in a closed chain, we had no evidence to show the manner in which the atoms were united. Subsequently Mr. W. H. Perkin read a paper on the formation of coumarine and of cinnamic, and of other analogous acids from the aromatic aldehydes. These acids, of which twenty are described in the paper, were obtained by the action of a metallic salt and acid anhydride, such as sodic acetate and acetic anhydride on an aromatic aldehyde; the latter part of the paper contained an account of the acids obtained from coumarin.

Anthropological Institute, January 30.—Annual meeting.—Col. A. Lane Fox, F.R.S., president, in the chair.—The Treasurer presented his Report, which showed that the finances of the Society were in a satisfactory condition. The President delivered his anniversary address. It gave a short *résumé* of the papers that had been read during the past year. From the Report of the Council it appeared that there had been an increase of members in 1876 over deaths and retirements. The following Officers and Council were elected to serve for 1877:—President, John Evans, F.R.S. Vice-presidents: Prof. George Busk, F.R.S., Hyde Clarke, Col. Lane Fox, F.R.S., A. W. Franks, F.R.S., Francis Galton, F.R.S., E. Burnet Tylor, F.R.S. Directors and Hon. Secs.: E. W. Brabrook, F.S.A., Capt. Harold Dillon, F.S.A. Treasurer, J. Park-Harrison, M.A. Council: J. Beddoe, F.R.S., J. Barnard Davis, F.R.S., W. Boyd Dawkins, F.R.S., W. L. Distant, Robert Dunn, F.R.C.S., Charles Harrison, F.S.A., H. H. Howorth, F.S.A., Prof. T. McK. Hughes, F.G.S., Prof. Huxley, F.R.S., A. L. Lewis, Sir John Lubbock, Bart, M.P., F.R.S., R. Biddulph Martin, F. G. H. Price, F.R.G.S., J. E. Price, F.S.A., Prof. Rolleston, F.R.S., F. W. Rudler, F.G.S., C. R. Des Ruffières, F.R.S.L., Lord Arthur Russell, M.P., Rev. Prof. Sayce, M.R.A.S., M. J. Walhouse, F.R.A.S.

Victoria Institute, January 5.—Dr. C. Brooke, F.R.S., in the chair. Mr. David Howard, F.C.S., read a paper upon the structure of geological formations as an evidence of design. After which, a paper by Principal Dawson, F.R.S., on the recent discovery of numerous flint agricultural implements in America was read.

Institution of Civil Engineers, January 30.—Mr. George Robert Stephenson, president, in the chair.—The paper read was on the combustion of refuse vegetable substances for raising steam, by Mr. John Head, Assoc. Inst. C.E.

Berlin

German Chemical Society, January 15.—A. W. Hofmann, vice-president, in the chair. E. Mulder wishes to substitute the following expression, $M = d$, for the usual expression of the law of Arvogadro, $M = 2d$, by accepting as the atomic weight of hydrogen not 1, but 0·5.—I. Boguski and N. Kagander, in continuing their researches on the quantity of carbonic acid evolved in a given time by the action on marble of acids of different strength, arrives at the conclusion: that the velocities of the evolution of carbonic acid are inversely proportional to the molecular weights of the acids employed.—A. Christomanos recommended several modifications of the usual methods of analysis of chrome-iron-ore.—A. Basarow described for lecture purposes a miniature torpedo, containing only three grams of gunpowder, and sufficing to throw up water from a pail to the height of twenty or thirty feet.—F. Frerichs proposed, for organic analysis, to heat the compound in sealed tubes with oxide of mercury, and to determine the volumes of CO_2 and of O.—C. Göttig has found that the ordinary method of forming aldehydes from acids by distilling their calcium-salts with formiate of lime, holds good for the production of ethyl-salycylic aldehyde, but not of salicylic aldehyde.—A. Ladenburg has observed slight differences in the two bodies, $N(C_2H_5)_3.C_7H_7I$ (iodobenzyl-tri-ethylamine) and $N(C_2H_5)_2C_7H_7.C_2H_5I$ (iodo-ethyldiethyl-benzylamine), the former, treated with HI yielding iodide of benzyl, while the second does not yield this product. He thinks, therefore, that these two compounds are isomeric, that nitrogen is triatomic, and $NH_3.HCl$ a molecular combination. The same chemist states oxythymochinone to have the melting-point, 173°–174°, and not 187°, as formerly observed. He upholds the views regarding the constitution of this body lately published by him in a separate form.—R. Anschutz and G. Schultz obtained phenanthrenchinonimide by the action of alcoholic ammonia on phenanthrenchinone,

$$C_{14}H_8O_2 + NH_3 = C_{14}H_9NO + H_2O.$$

—H. Schwanert reported on several derivatives of dinitrotoluol-sulphonic acids.—A. Berndtsen described the aldehyde of thiobenzoic acid obtained from thiobenzamide by the action of nascent hydrogen :—

$$\underset{\text{thiobenzide}}{C_6H_5 . CS . NH_2} + 2H = \underset{\text{thiobenzaldehyde}}{C_6H_5 . CS . H} + NH_3.$$

A second body formed simultaneously forms the subject of further investigations. The same chemist has succeeded in transforming acetonitrile into acetothiamide, colourless prisms fusing at 108° :—

$$CH_3 . CN + SH_2 = CH_3CS . NH_2.$$

C. Seuberlich, by the action ot sulphuric acid on a mixture of gallic and benzoic acids, has obtained black metallic needles of anthragallol, $C_{14}H_8O_5$.—C. Liebermann communicated that H. E. Armstrong has transformed nitrosothymol into amidothymol and into thymochinone by oxidation, and that R. Schiff has proved that nitrosothymol can be transformed into ordinary dinitrothymochinone. These facts prove the relative position of the constituent groups to be different than supposed by Ladenburg. F. Tiemann described a new acid, $C_9H_{10}O_4$, homovanillinic acid, obtained from acetyl-eugenol by oxidation, which, treated with alkali, yields homoprotocatechic acid, $C_8H_8O_4$. The relations of these substances are :—

$$\underset{\text{Vanillinic.}}{C_6H_3\left\{\begin{array}{l}COOH\\OCH_3\\OH\end{array}\right.} \qquad \underset{\text{Protocatechic acid.}}{C_6H_3\left\{\begin{array}{l}COOH\\OH\\OH\end{array}\right.}$$

$$\underset{\text{Homovanillinic.}}{C_6H_3\left\{\begin{array}{l}CH_2COOH\\OCH_3\\OH\end{array}\right.} \qquad \underset{\text{Homoprotocatechic acid.}}{C_6H_3\left\{\begin{array}{l}CH_2COOH\\OH\\OH\end{array}\right.}$$

Conjointly with A. Herzberg, the same chemist has obtained cinnamic acid by the action of acetic anhydride on benzaldehyde. The reaction gives a better yield than chloride of acetyl, and is also applicable to salicylic aldehyde and to vanilline.—C. Vogel communicated spectroscopic reactions of magnesia with purpurine and with cochineal.—The chairman read a letter of Prof. F. Wöhler, in Göttingen, in which he accepts the office of president of the Society for the ensuing year, with thanks for this acknowledgment of his past services to science.

Paris

Academy of Sciences, January 29.—M. Peligot in the chair.—The following papers were read :—Note on the stability of arches, by M. Resal. He gives an analytical demonstration of the theorem, that when the thrust at the key-stone of an arch is minimum the curve of pressures is tangent to the intrados at the joint of rupture.—Reply to Dr. Bastian, by M. Pasteur. He defies Dr. Bastian to obtain the result he got with sterile urine, provided only the solution of potash used be pure, water pure, and potash pure, both exempt from organic matters. If Dr. Bastian takes impure potash, M. Pasteur authorises him to take it or anything else in the English pharmacopœia, if only it be heated previously to 110 degrees for twenty minutes or 130 degrees for five minutes.—On the germs of bacteria in suspension in the atmosphere and in water, by MM. Pasteur and Joubert. An inquiry suggested by the discussion with Dr. Bastian. The germs are shown to be very numerous in water, like that of the Seine; they occur in the distilled water of our laboratories, and can traverse all filters. They are absent from water of springs in the interior of the ground that has not been reached by dust from the atmosphere nor by water circulating above ground.—Researches on the irisation of glass, by MM. Frémy and Clemandot. They reproduce at will the irisation sometimes observed in glass (from some old tombs, &c.), by subjecting glass under heat and pressure, to the action of water containing about 15 per cent. of hydrochloric acid. The chemical composition and the conditions of annealing and tempering, influence the phenomenon. (Particulars later). Bottle glass for holding an acid liquid like wine should not irisate under action of acids; if it does the liquid is quickly altered. The author's method enables him to test the quality of a glass beforehand, by submitting it to dilute hydrochloric acid. —Report on a memoir by M. Henri Becquerel, entitled "Experimental Researches on Magnetic Rotatory Polarisation." He studies the relation between this property and the index of refraction, examining bodies with a high index; and these he finds to have a high rotatory power. In solutions of salts the rotatory power increases rapidly with the concentration. He demonstrates also an anomalous rotatory dispersion accompanying negative magnetic rotation.—On the products obtained by calcination, in a closed vessel, of the wash (*vinasses*) of molasses of beet, by M. Camille Vincent.—On a new arrangement of the rods of lightning conductors, by M. Janiant. The rods are generally six metres long, weigh not less than 120 kilogrammes (involving much strain), and cost, with their copper point, some 300 francs. The author arranges four iron corner channels in form of a quadrangular pyramid connected at the base by iron sockets attached to the timber work. At the top the channels are thinned to the prescribed diameter of 2 cm. for the copper point, and this is screwed on an iron rod, which traverses the system from top to bottom, and ensures metallic communication with all the parts. The system weighs only 20 kilogrammes, and is half the price of the other.—On the effects produced by introduction of foreign substances into carbon, in preparation of carbon points for the electric light, by M. Gauduin. These experiments were made in 1875, with phosphate of bone, lime, chloride of calcium, borate and silicate of lime, pure precipitated silicon, magnesia, borate and phosphate and magnesia, alumina, and silicate of alumina. The salts of lime gave the greatest increase of light; with the first substance, the intensity was doubled. Silicon diminished the light.—Treatment of phylloxerised vines by sulphide of carbon fixed in pulverulent matters, by M. Fournet.—On the necessity of abandoning the Baumé areometer and replacing it by Gay Lussac's densimeter, by M. Maumené.—On the development of the ellipse, by M. Laguerre.—On the two theorems of M. Clebsch relative to curves quarrable by elliptic functions or by circular functions, by M. Marie.—Researches on the spectra of metals at the base of flames, by M. Gouy. The base of the flame gives, up to a very small height, a spectrum resembling the electric spectrum of the metal examined.—On the preparation of alkaline nitrites, by M. Etard.—Researches on the formation of natural sulphurous waters, by M. Plauchud. Sulphurous mineral waters owe their formation to the reduction of various sulphates produced under the influence of living beings acting like ferments. It is possible that not every sulphuration of water is attributable to ferments, as acetic acid may be produced by spongy platinum as well as *mycoderma aceti*.

CONTENTS