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John Steeple, delt. (From a Sketch by R. E. Alison) M & N Hanhart lith

THE CAÑADAS OR ATRIUM. 7817 feet
above the Sea-level.

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JANUARY, 1866.

I. TENERIFFE.

An Ascent of the Peak and Sketch of the Island. Illustrated.

By Robert Edward Alison.

In this paper it is my intention to record briefly some of my experiences during a residence in the Island of Teneriffe, and I shall describe whatever appeared to me of value, according to my habits of investigation; imperfect as the narrative may be, I hope it will be the means of inducing more capable observers to visit that interesting island, which, on a small scale, offers a very ample field for the labours of the man of science; where the vegetations of most distant regions meet together, and where a climate can be obtained, varying within a few miles from the softest temperature of Italy to the cold of an English March.

In consequence of a very severe affection of the lungs, I was ordered to try the climate of Madeira; on my arrival at that beautiful island, the medical man I consulted told me that the climate of Funchal was not suitable for my complaint, and advised me to try that of Teneriffe, where I could reside during the summer months at a considerable elevation above the sea, and during the winter on the coast, and thus enjoy an equable temperature throughout the year; his advice appeared to me so good, that I resolved to adopt it.

I left Funchal with a strong north-east trade wind, which we expected would enable us to reach Teneriffe in about thirty hours, as the distance is only about 200 miles.

After passing Madeira, we remarked the peculiar change in the colour of the sea, which passed from a cobalt blue to a very deep Prussian blue, probably caused by the increased depth of the ocean and the very blue colour of the sky. I had been told that the lofty cone of the Peak of Teneriffe could be distinctly seen at a distance of 120 miles; about an hour after sunrise we supposed that we were within one-half of that distance, but no Peak was to be seen, to my great disappointment. I found afterwards that it is seldom seen at a great distance during the warmest months of summer, but is very clear and distinct during the cold months, or before rain and immediately after it, when the transparency of the air is greatly increased by a certain quantity of vapour which is held in suspension through the atmosphere. Besides, the upper part of the Peak, or "sugar-loaf," which is the only part covered with whitish-coloured pumice, reflects more light than the sides of the volcano, which are covered with trachytic lava; thus the cone reflects a whitish light, which contrasts with the surrounding sky, and enables it to be seen at a distance, when it subtends an angle sufficiently large to make an impression on the retina. As the Peak may serve to direct the navigator and enable him to verify his position, the exact distance from which it can be seen is of importance. We stood rapidly on our course, and when we approached within twenty miles of the island, we saw the top of the Peak glistening through some breaks in a mass of cumulose clouds; from its extreme whiteness, I thought that the cone was covered with snow, but it was merely the reflected light from the pumice.

In a few hours we came to an anchor off Orotava, on the north side of the island, which is exposed to all the swell caused by the N.E. trade-winds. Such rolling I had never experienced, the vessels occasionally showing almost their keels, or what they had upon their decks. The landing, however, is not bad, as it is sheltered behind numerous pinnacles of volcanic rocks, which break the force of the rollers.

What a new scene presented itself when I put my foot on shore, so different from what I had left in London. Such rich dazzling colours, and such Murillo-looking countenances among the lower orders, set off in a great degree by a glowing mid-day sun. The graceful and picturesque dress of the peasantry was particularly striking to a new-comer; the women wear no bonnets, but a half-square of white kerseymere or cashmere, or fine flannel trimmed with white satin ribbon with rosettes at the corners, is thrown over the back of the head; unfortunately, its neatness is spoilt by an odious steeple-crowned black hat, similar to that worn by women in parts of Wales. Their hair, which is always attended to with great care, is drawn tightly over the forehead, made as smooth as possible, and occasionally collected at the back into one or two tails, and most have a small round curl fixed close to the temples. Their tall figures and graceful movements are set off by their pretty feet, which are clothed, when they go to church, with silk stockings and coloured satin shoes. The ladies follow the Paris fashions, with the addition, when they go out, of the graceful mantilla of black lace, which hangs loose down on the figure, and that regular accompaniment of the Spanish belle, the expressive fan, the dexterous management of which is quite an accomplishment of a lady of fashion.

The dress of the male peasantry is picturesque: it consists of a cloth jacket, a showy waistcoat embroidered at the back, velveteen breeches open at the knees, ornamented with a number of buttons; when travelling their jacket is generally dispensed with; their well-made legs are covered with long leather gaiters ornamented with coloured leather; a straw hat shadows their generally fine features: altogether they present models of fine masculine forms capable of enduring great fatigue. This pretty and suitable dress is, however, spoilt in a great degree by wearing over it, even in the hottest day, an English blanket made into a sort of cloak formed by a running string round the neck. It is said, that this part of their dress was used by the Guanches, the ancient inhabitants of the island.

When I landed at Port Orotava in the begining of July, the thermometer in the shade ranged during the day from 73° to 77°, a temperature which I found relaxing, therefore I was anxious to remove to the romantically situated Villa de Orotava, three miles off and 1,141 feet above the port, with a temperature several degrees lower. But there was a serious obstacle to my intended residence at the Villa, as at that time both hotels and lodgings were unknown; however, I obtained a letter of introduction to the prior of the Augustine convent there, who possibly might give me (although a heretic) the use of a cell in his large, but thinly filled convent. Armed with my letter, I called on the worthy prior; on presenting it to him, I addressed him a few words in indifferent Spanish, but I was soon very agreeably surprised by being seized warmly by the hand and answered in a rich Hibernian accent, "How glad I am to see a countryman here." He kindly offered me a choice of cells, but in doing that, he added, "I can only offer you the bare walls and the use of our cook as long as you think proper to reside among us." I soon sent up the necessary furniture, and passed twelve months most agreeably with the warm-hearted prior and his friars.

The career of the prior was not a common one; he had passed his youth as an officer in the British army, and had served during the whole of the Peninsular war; having become tired of the ennui of his half-pay inactivity in Ireland, he went to pay a visit to his old friends in Spain, where he was persuaded to take the friar's cowl, and afterwards became a prior of the Augustine convent of the Villa de Orotava.

I can testify feelingly to the superiority of the climate of Teneriffe to that of any European district for all affections of the lungs. When I left England I had all the bad symptoms of pulmonary consumption, brought on by a neglected cough, yet in a very short time, without any medicine, they all disappeared. As a proof of what climate did for me, I will mention that three months after my arrival I made an attempt to ascend the Peak, but was obliged to return when within a few hundred feet of the top, in consequence of my men refusing to go any higher. I do not wish it to be supposed that the climate will *cure* consumption, or where tubercular disease has occupied a considerable portion of the lungs, which it had not in my case; but its warm, dry, equable temperature, which can be obtained throughout the year by varying the altitude, is a most powerful remedial agent, and will do more to ward off that sad malady than any other part of the world, excepting possibly the city of Mendoza, on the eastern foot of the Andes, in the republic of Rio de la Plata. A scientific French gentleman who had observed the temperature of the Villa de Orotava during some years, informed me that his self-registering thermometer had never been below 12·5 C. = 54·5 F.: during the winter I passed there I never saw it below 55·5 F. The following is the mean temperature of Santa Cruz, the principal port and town on the south side of the island; San Christobal de la Laguna, the capital, 1,740 feet above the sea; and the upper part of the Villa de Orotava, 1,121 feet above the sea.

	Santa Cruz.	Laguna.	Villa de Orotava.	
March . .	67·10	58	62·75	
April . .	67·25	58·75	63	
May . . .	72·10	62	67	
Mean .	68·81	59·58	64·25	Spring.
June . . .	73·85	64·87	68·87	
July . . .	77·25	69 12	70·12	
August . .	78·85	70·85	73 88	
Mean .	76 65	68·28	70·95	Summer.
September .	77·25	70	72·90	
October . .	74·64	66	70·40	
November .	70·40	61·87	65·85	
Mean .	74·09	65·95	69·71	Autumn.
December .	65·81	58	62 15	
January . .	63·80	54·75	59·25	
February .	64·34	56	60	
Mean .	64·65	56·25	60·40	Winter.

Mean Annual Temperature of Santa Cruz . . 70·05
" " Laguna . . . 62·51
" " Orotava . . 66·34

It will be seen from the preceding table, that the summer warmth is prolonged to the month of November, which month is 3°·15 warmer at Santa Cruz than April. Penzance is the mildest part of England, there the mean temperature of November is only 45° or 25°·40 below that of Santa Cruz.

The houses of the nobility and gentry are built after the Moorish style, which is pre-eminently suitable to warm climates; they form a hollow square which is frequently filled with orange trees, oleanders with their rose-pink flowers, or bananas whose delicately green leaves throw around a delicious shade. The lower part of the houses contains stores for wine, &c., or offices; above is an open balcony leading to the reception rooms and bed chambers; the whole crowned by a high square tower ("mirador") with a flat roof: those of the Villa de Orotava overlook two extinct volcanoes, an enchanting valley under a high state of cultivation, bearing the vine, oranges, lemons, and various tropical fruits, with the sea in front, bounded on the west by an almost vertical cliff, or crater flank, called Tigayga, above which are various mountains, from 9,000 to 10,000 feet high, crowned over all by the white cone of the majestic Peak, towering to the elevation of 12,200 feet. These flat-roofed towers are a great source of enjoyment to the gentlemen of the island, who assemble on them in the cool of the evening, to chat, smoke their cigars, and sometimes to have rival games of flying kites, of which they are extremely fond.

Vegetation assumes here her fairest forms; the south side of the island is in most parts arid and burnt up, but on the north side it is adorned with many of the vegetable forms which add so much beauty to the tropical regions. From the elevated plains of pumice, called the "cumbre," which crown the top of the entire island at an elevation of about 6,000 feet above the sea, one may plainly distinguish five distinct zones of vegetation, which are as marked as if they had been planted by the hand of man.

The first region, which may be termed that of the vines, extends nearly 1,500 feet above the sea, and although you occasionally find vines 500 or 600 feet higher, yet the grapes are not considered fit for making wine. In this region are found all the fruits of Southern Europe: date-palm, *Papaya*, *Banana*, sugar-cane, the various tribes of *Cucurbitæ;* in the botanical garden near Orotava there is the coffee-tree, cinnamon-tree (*Laurus cinnamomum*), and the bread-fruit tree (*Artocarpus incisa*): the *Arum Colocasia* is very common, it produces a species of arrowroot; the *Palma Christi*, or castor-oil plant, and the Spanish carnation (*Poinciana pulcherrima*) are hedge-weeds. Some of the arborescent Euphorbiæ are peculiar: the *Euphorbia Canariensis* is in bushes ten to twelve feet high and twenty in diameter; it is found at various elevations, but it thrives best below 2,000 feet; when this plant is wounded, it exudes a white milky juice, which is very acrid and caustic; when inspissated it is employed instead of cantharides by the natives, formerly it was used considerably in England as a cathartic, emetic, errhine, and rubefacient when properly diluted, but its internal use is now discontinued in medicine. At the upper part of this zone, immense plants of the *Cacalia Kleinii* thrive with much luxuriance. That extraordinary tree the dragon tree (*Dracæna draco*) grows only in this zone; it produces a fine scarlet gum, called by the old Arabian physicians "dragon's blood." In a garden in the Villa de Orotava is a renowned dragon tree, supposed to be many thousand years old: when the Spaniards arrived at Orotava in 1493 the trunk was then hollow. It is about 60 feet high and 49 in circumference near the ground, and 35½ feet at 6 feet from the surface. Humboldt made it only 45 feet in circumference, but he must have measured it higher up; I once cleared the ground round the trunk and found it 49½ feet. Many years ago a large arm was blown down by a storm; the present proprietor has very properly taken measures to preserve the tree, by supporting it with props and masonry.

During many centuries this zone gave employment to the greatest part of the population of the island in the cultivation of the vine, but some years ago the grapes became diseased, which produced much distress among the poor; fortunately, they took to cultivating the cochineal insect on the *Cactus cochinellifera* and *Opuntia vulgaris*. It was raised with great success on the south side of the island, whose arid and parched surface appeared at first to be particularly favourable to it, as it yielded occasionally a profit of 45*l*. per acre; but it proved a very precarious industry, for although the female insect prefers a high temperature, yet it is killed by a high radiation. Fortunately, the vines have recovered from their disease, and the cochineal trade has fallen off in importance.

The second zone of plants, extending from 2,000 to 3,400 feet above the sea, may be properly called the region of laurels; by the natives it is termed "Alta Verde,"—Green Mount. This region exhibits thick woods of Canarian oak (*Quercus Canariensis*), *Laurus nobilis*, *L. indica*, and *L. fœtens*, two sorts of chestnut trees, a wild olive (*Olea excelsa*), some heaths, such as the *Erica arborea* and *E. scoparia;* masses of daphne, yellow St. John's wort, some species of the *Sideroxylon*, several trees of the myrtle species, round which was entwined the Canarian ivy (*Hedera Canariensis*). There is found in great abundance in this zone, as well as at an elevation of more than 9,000 feet, a very beautiful leguminous plant, called by the natives "Codeso" (*Codonocarpus frankenoides*); it has composite leaves of a light-green colour, a woody stem, and branches out like a tree; it makes an excellent fire for the traveller, and when burnt, gives out a strong aromatic smell. In the lower part of the zone are large bushes of two or three species of Hypericums, but only one (the *H. Canariense*) is indigenous; this luxuriant plant is found also in the lower zone. The Campanula and Chrysanthemum show themselves wherever the ground of this zone is covered with moss.

The third zone, which is generally enveloped in clouds towards the evening, extends to 5,400 feet above the sea. It may be considered as the true region of the arborescent ferns and that beautiful and useful tree, the Canarian pine, which will be in a few years swept away by the woodman's axe. Where this has been done on the north-west side of the island, they have, as might have been expected, suffered much from drought. The pine is mingled with a juniper tree, called the *Juniperus oxycedrus*, and wherever there was a spring of water, it was surrounded by seven or eight species of ferns, but only two of them were peculiar to the island,—the *Asplenium Canariense* and the *Trichomanes Canariense;* the Arbutus is very luxuriant, but it flourishes equally well in the upper part of the second zone.

The fourth zone may be said to extend to the elevation of 7,000 feet; in this division, the vegetation is much mixed with that of the upper part of the lower zone, such as the Canarian pine, juniper, and large flowery bushes of *Retama*, the Spanish name for two species of mountain broom (*Spartium monospermum* and *Spartium nubigenum*).

The fifth and upper zone consists of plains of pumice, whose parched and barren aspect is only occasionally relieved by detached bushes of *Retama* and "*Codeso,*" whose dry and pale-green leaves gain a scanty nourishment amid the scorching heat of the sun. Even at the foot of the Peak, at an elevation of 8,957 feet, with a radiation sometimes of 180°, and a depression of 54° of the wet-bulb thermometer, a lilac-coloured violet is found (*Viola cheiranthefolia*), and the *Scrophularia glabiata* and some lichens on the Peak near the Ice Cave, at an elevation of 11,098 feet.

When I mention these different zones, or bands of vegetation, it must not be thought that they appear so very distinct as you pass through them, as in fact they are much blended, particularly at the verge of every zone. As I was in the habit of passing through three of the belts of vegetation three or four times a week, I paid great attention to their lines of demarcation, which I endeavoured to ascertain in the following manner: I ascended some commanding position, and noted the peculiar vegetation from one salient point to another, as far as I could see, which I measured afterwards with a barometer. At first, I attempted to measure the elevation above the sea of the last tree in every zone, but it was attended with so many difficulties that I abandoned the plan.

In the "Cumbre," or plains of pumice, which are at an elevation of from 6,500 feet to the foot of the Peak, which is 7,817 feet, are several caves in the lower cliffs, containing bodies of the Guanches, or aborigines of Teneriffe. They were preserved in a manner very similar to that adopted by the ancient Egyptians. The internal cavities were filled with odoriferous gums, and the body was enveloped in the skins of goats, which had preserved in some degree their suppleness. Round the necks of some bodies I found in a cave in the Cañadas del Pico, 7,700 feet above the sea, were necklaces composed of small discs of baked clay, of different degrees of thickness. The necklaces are very similar in size and material to those I have seen round the necks of the preserved bodies of the ancient Indians of Peru, who employed them as numerical signs, and to record dates and events. One round the neck of a body discovered near Arica, in Peru, was almost identical with those I have seen round the necks of the embalmed Guanches.

The history of the Guanches is involved in the greatest obscurity; probably, they were a branch of the great Lybian stock. Plutarch calls the Canaries the Fortunate Isles, and it is conjectured that they were the site of the fabulous gardens of the Hesperides. Although the Canaries were visited by the Phœnicians, they were lost to the world for nearly fourteen centuries, from the time of Juba, a few years before the birth of Christ, till the year 1330, when a French ship was driven on one of the islands. From that time various expeditions attempted their conquest; the principal one was headed by Jean de Bethencourt, a Norman noble, who landed in 1400, but was ultimately obliged to retire. The Spaniards ultimately reduced Teneriffe and the other islands in 1493. At the time of the conquest, the island was governed by seven independent chiefs, whose manners and customs differed considerably, although their domains were only separated by walls of loose stones. About a century after the conquest, this singular people became utterly extinct. It is said that numbers retired to caves in the mountains, and starved themselves to death, but there is no doubt that disease and misery caused them to melt rapidly away. In the library of the convent where I was residing, there was a manuscript journal, which had been kept by a friar who had attended the last expedition of the Spaniards; it gives a most interesting and affecting account of the extreme humanity and bravery of the poor islanders.

Birds are in great variety; but I must not omit to mention the far-famed canary-bird (*Fringilla Canaria*); when I saw it first in its native woods, I could scarcely recognize it as the same species as our domestic yellow warbler, so much is the latter altered by domestication and repeated crosses. The native bird is grey on the wings, the belly is green, and the back a very dark grey; it builds on bushy trees or high shrubs; the nest is composed of moss, roots, feathers, &c.; it lays from four to six pale-blue eggs, and sometimes hatches six times in a season. It pairs in February, and moults in August and September. I was surprised to find that each flock has a different song; at first I thought that I had been mistaken, but the natives confirmed my observation. The note is between that of the skylark and nightingale. The natives assert that it is very difficult to rear, and generally dies in a couple of years if kept in a cage, though they do not appear to suffer from confinement, as they commence singing directly they are caged.

There is another indigenous linnet (*Fringilla teydensis*) which I have seen at the foot of the Peak; the tinto negro is said to be peculiar to the island, but it is found also in the island of Madeira. Hawks, kites, the red-legged partridge, and other species of Tetraonidæ are numerous.

The fish are of considerable variety. From its peculiar position the island is visited by many migratory shoals, and its fauna thus combines all the fishes of the coast of Africa, of the Mediterranean, and of the West Indies. The bream is found in large numbers between the coast of Africa and the Canaries, and when salted forms a considerable article of export. The tunny is of large size, and is esteemed when pickled. Some varieties of the *Cephalopoda*, particularly the *Octopus*, are eaten by the lower orders, and considered a luxury. Another sort, commonly known as the rock-squid, has a body not larger than a man's fist, yet its arms are four feet long.

As soon as I was strong enough to support much fatigue, I determined to visit the top of the Peak, or "Teyde," as the natives formerly called it. My native friends begged me not to make the attempt, as the cold at that time of the year would be insupportable. But I considered such an opinion erroneous; I had made repeated excursions on foot to an elevation of nearly 7,000 feet above the sea, and once to 8,000 feet, when I suffered more from enormous radiation than from cold. In September the temperature in the shade, at 8,000 feet, was 40° F., while the black-bulb thermometer rose to 196°, or close to boiling point at that elevation.

The inhabitants are supplied with ice (or rather snow) by men who go up to the foot of the Peak for it during the winter months; and in the summer, to the Cueva de Hielo, *ice-cave*, which is 3,281 feet higher up. From the nature of their employment, I thought they would be the best men to accompany me, therefore I engaged the head man and his sons. We got up without danger to the Cueva de Hielo, when they refused to proceed any farther, under the plea that we could not pass the night on the snow without a tent or any extra clothing, therefore I was reluctantly obliged to return.

In February, I agreed with a couple of men to accompany me to the top of the Peak, under an agreement that they were to receive no pay if they turned back against my orders.

The usual plan of those who ascend the Peak, is to leave Port Orotava about one o'clock in the day, to enable them to reach the *Estancia de los Ingleses*, where they pass the night under the shelter of some rock, and then to resume the ascent sufficiently early to see the sun rise from the top of the Peak. As I wished to pass some time at the Estancia to examine the surrounding lavas, and to observe the decrement of temperature from the coast, the Villa de Orotava, and my point of observation, I left the Villa at 4 A.M., at which hour the thermometer stood at 56°·5, the wet-bulb thermometer 53°, and the barometer 28°·78, equal to 30 inches reduced to the level of the sea.

Soon after we left the upper part of the town, we entered the Camino de Chasna, which is dignified by the name of a road, although, like almost all the highways in the island, it is only a steep and rugged surface of lava. My muleteer, guide, and myself moved along in Indian file, and, as we proceeded upwards, the cold gradually increased, particularly after we passed over the crest of the first range of hills which bounds the valley of Orotava. The valleys, and high up some of the mountains where there was vegetation, were covered with dense vapour, but it did not at that hour extend to where we were ascending; above was the intensely blue starry vault of heaven, and in front the clear outline of the Peak covered with snow, looking down upon us in majestic grandeur. There was a peculiar wildness in the scene, which for a time was enlivened by the rather melodious chant of my two men, but towards break of day they appeared tired, and notwithstanding the cold, I found much difficulty in keeping my eyes open; indeed, my men said that I had been dozing, which was very probable, as I had not been to bed the previous night, that I might be ready to start in good time.

About 7 A.M. we crossed the barranca, or ravine, of Pilloni, and that of Pino Dornajito, which is 3,410 feet above the level of the sea; it is so named from an enormous Canarian pine-tree that grew near the western side of the ravine. It is said that this tree was full-grown at the time of the conquest; after having stood the storms of so many ages, it was at last swept into the ravine by the dreadful waterspout that devastated the northern part of the island on the night of the 7th November, 1826; this tree, though partly destroyed, still measured when I saw it, 128 feet in length and 30 feet in circumference.

Under a precipice in the middle of the ravine, is a small spring of water, and a wooden cross at the side of it; the temperature of the spring was 56°, that of the air 40°, and the wet-bulb thermometer 39°·5. At the time of the waterspout a body of water, some hundred feet wide and thirty to forty deep, fell over this spring and cross without doing the least damage, which the peasantry attribute to the merits of the cross, forgetting that the water in falling over the precipice would form a curve, and thus could not touch the vertical wall below.

From the great depth of this ravine, the various rocks that form its perpendicular sides can be observed, as they form a perfect section; the uppermost rock consists of decomposed phonolite, below rough trachytic lava, with vegetable mould to the depth of three feet; next is a sort of volcanic breccia or conglomerate, held together by a brown mud, and afterwards, beds of yellow and grey tufa four to five feet in thickness, succeeded by various alternate layers of dark trachy-dolerite and brown mud. As it was impossible to examine this interesting ravine on my journey up the Peak, I afterwards occupied myself several days in making a plan of it, and taking specimens of all the various rocks along a distance of several miles.

The hygrometric state of the atmosphere showed that we were approaching the lower region of the clouds, the temperature fell rapidly, and the wet-bulb thermometer showed absolute saturation, at the same time vegetation became so luxuriant, that it was difficult to observe the nature of the lavas.

The tree-heaths were of considerable size, some were 18 feet high, with stems nearly 30 inches in circumference; they were mixed with laurels, cystus, and various other arborescent shrubs. It is worthy of remark, that the leaves were of a uniformly dark-green colour. The luxuriant vegetation of this zone is no doubt owing to its greater humidity, as the clouds generally remain at this elevation during the night and the early part of the morning. As we advance to the upper verge of this zone, the air contains less moisture, the radiation becomes much greater, and the vegetation less luxuriant, with the leaves of a light-green instead of a dark-green colour.

The lavas appeared to have flowed in numerous streams from different openings, and their appearance varied considerably according to the angle they flowed over; for instance, where it had run up a slight ascent, it was twisted and contorted, as if it had been less viscous, showing that the surface had become refrigerated. I took specimens of some of the lower streams which were of trachyte, containing pyroxene, hornblende, and mica; over them were other streams, of what may be termed a dolerite lava, it contained crystals of red, brown, and greenish colours, apparently labradorite, and pyroxene: some of the other streams contained crystals found in both kinds of lava, coupled with hornblende and olivine (peridote); they may be fairly called, I think, a sort of trachy-dolerite; they were all highly magnetic. Many of the lavas were much decomposed, with the pores on the surface free from crystals, which had no doubt fallen out, as I always found them internally.

We kept gradually ascending; in crossing the Barranca Haya, we were rather annoyed by the vapour of the clouds condensing in our clothes and hair, producing to our feelings a degree of cold much greater than the 39°·5 indicated by our thermometer; the wet-bulb thermometer proved that the atmosphere was saturated with moisture. The sensible cold was increased by a strong local current of wind from the west-by-south, although the wind below and above was blowing from N.N.W.

At a quarter to eight A.M. we entered the Llanos de Gaspar (the plains of Gaspar), and left the clouds considerably below us; here the vegetation became very scanty; almost the only plants on the surface were patches of Canarian thyme. This desolate spot was, however, particularly interesting, as it was evident that a considerable part of the waterspout which did so much damage in November, 1826, had burst here, cutting the surface into a vast number of ravines, some of them of great depth. From the appearance of the surface, the columns of water which fell must have been very numerous, as in ten or twelve different places the lava was cut into deep trenches, some fifteen and twenty feet deep, with the soil which had been between completely washed away; many of these channels frequently conveyed into one, which formed at last a destructive and overwhelming ravine, in some places 75 feet deep and a quarter of a mile wide; the body of water swept away part of the town of Garrachica in the valley of Orotava, numerous houses and vineyards, with a battery and its guns at the Port Orotava. When I saw the ravine, which had been cut through numerous layers of compact lava, I thought it had been the work of ages instead of only part of a single night.

At half-past nine A.M. we entered the last zone of vegetation, the surface was covered with white lapilli, and protruding masses of trachyte and porphyritic lava, occasionally mixed with pumice. The vegetation for some time had been gradually becoming less luxuriant and more scanty, till here it was reduced to the *Codeso*, and large tufts of mountain broom. The dry, close, and ligneous formation of its leaves enables it to support the immense difference of climate it has to undergo every four-and-twenty hours. During the summer season, in the daytime, the intensity of solar radiation is almost insupportable, for it is sometimes as high as 210° F.; on the contrary, the nights are extremely cold; the dryness is excessive, as I have observed the dew point as great as 45° to 50°, and to rise again in a few minutes to 24° from a passing cloud.

At ten o'clock we came in view of the foot of the Peak, but I was much disappointed when I was informed that we had still a two hours' climb before we could arrive at the foot of that part of it where the ascent was to commence. The view on our right was a novelty to a person who had not been accustomed to ascend great elevations. The valleys below were filled with vapours, whilst over the sea and the regions above were quite clear. Objects below were unusually refracted; two brigantines, which were at a considerable distance, presented inverted images of some of their parts; but what was very singular, they appeared to alter their form as I changed my position; sometimes the masts and vessel appeared as if they were separated, then the masts touched each other, and afterwards rapidly increased in length, presenting quite a distorted appearance. After we had ascended a short distance, this refraction or *mirage* went off, and the vessels assumed their natural appearance.

The Cañadas del Pico (see Plate I.) is an immense plain of an ancient crater, covered with yellow and white pumice, extending round the Peak from W.S.W. to E. by N., forming part of an ellipsis 8 miles by 7, or 23 miles in circumference. The surface near the foot of the Peak is 8,957 feet above the level of the sea; rather towards one side of this plain or crater, in latitude 28° 17′ N., and longitude 16° 39′ 45″ W., rises the Peak to a further elevation of 3,243 feet, or 12,200 feet above the level of the sea.

This plain is surrounded by nearly vertical walls of lava, which would debar all possible entrance if they had not been broken across in some places by a great convulsion of nature; the one by which we entered is very aptly named by the natives *El Pertillo*, the little gateway. The surface is dotted over with masses of reddish coloured and black trachyte and phonolite, which apparently are erratic masses, but on close inspection, it can be seen in many places that they are in some degree circular, and are very probably the tops of extinct craters, or rents of more modern date than the great plain or crater. These Cañadas form the only road of communication between the northern and southern parts of the island, but during the winter season they are sometimes impassable from the great depth of snow.

We passed a small extinct volcano, called Montaña Negra (*black mountain*), but more generally known by the name of Los Gorros; in it are several caves, which are used as ice-houses by the men who supply Santa Cruz and the other towns with snow; they collect it at the foot of the Peak at certain seasons of the year; when they cannot obtain it there, they go up to the Cueva de Hielo, which is 2,131 feet higher up, or 11,098 feet above the level of the sea.

At mid-day we arrived at the foot of the Peak, where we left our mules with some fodder we brought up for them. We remained there an hour to breakfast and to enable me to make the following observations:—

	In.
The Barometer stood at	20,654
Thermometer in the shade . . .	44° F.
Wet-bulb Thermometer . . .	4
Black ditto	140
Boiling point of water	196·7

I am not certain that this is perfectly correct, as it varied from 196°·4 to 196°·7, the bulb of the thermometer was not plunged into the water, but in the steam about an inch above the surface of the water.

We began to mount the Peak on foot, by a very steep ascent over a surface covered with yellowish coloured pumice, between two embankments or currents of trachytic lava, which had separated in cooling from the general mass called Mal Pais, situated at Alta Vesta de Arriba 10,621 feet above the sea. It is not quite correct to call them currents; although in continuous lines, the lava was not in connected masses, but in large detached blocks of various sizes and forms, that had apparently undergone various degrees of rapid and slow cooling; the most common description was a trachy-dolerite, with more or less felspathic minerals; some were obsidian, or volcanic glass, of a jet-black colour, having internally a shining vitreous lustre, breaking with a conchoidal fracture, and translucent at the edges. It is worthy of remark, that when I broke some specimens from the lowest part of a mass of obsidian they contained crystals of felspar, but in the upper part of the same mass, very frequently I could not discover a single crystal, as if they had fallen down to the bottom, when the mass was liquid, by their own specific gravity. On breaking some of them, they exhibited cavities containing an incipient crystallization forming concentric laminæ of a lighter colour than the rest. In some places I picked up pieces which were slightly convoluted, containing small crystals of pyroxene and glassy felspar.

Another singular circumstance is, that the pumice taken from the Cañadas of the Peak is heavier and contains more silica and alumina, and less potash and soda, than that on the sides and top of the Peak; the latter contained about the same quantity of silica and alumina as the trachy-dolerite.

The following is the analysis made for me by the late Dr. Andrew Ure:—

	Silica.	Alumina.	Potash.	Soda.
Trachy-dolerite, from the Peak .	57	16 95	1·14	6·40
Pumice, ditto	59·87	15·89	10 20	3·15
Ditto Cañadas	62·40	14·97	6·25	1 96

It will be seen that all this pumice contains a smaller amount of silica than that from the Lipari Isles, which according to Klaproth contains 77·50 of silica and 17·50 of alumina.

Some of the blocks of lava I examined higher up the Peak had more of a porphyritic than a trachytic character, as they contained blotches of crystals of a greenish and greyish-white colour, which I mistook for ordinary felspar; but I was informed on good authority that they were pyroxene, labradorite, and chrysolite, therefore the blocks may be more properly considered a species of basalt, though they had all the spongy and rough appearance of a trachyte. Occasionally there were detached blocks of phonolite, of a greyish-blue colour, containing much felspar and mesotype; it made a smooth fracture, and had the peculiar metallic sound of that rock when struck with a hammer.

After a very fatiguing but not difficult ascent, which took us an hour, including the time occupied in examining the lavas, we arrived at a part of the Peak called *La Estancia de los Ingleses de Abaxo* (the lower halting place of the English), which is 9,930 feet above the level of the sea. The pumice here forms a tolerably level surface of a few hundred feet square; towards the N.N.E. side of it are some large scattered blocks of obsidian, under the lee of one of them we piled up some pieces of lava to form a slight shelter from the wind, which was extremely cold, and blew such a gale that we were frequently obliged to hold on to the rocks to avoid being blown away, and which for some time made all our efforts useless to light a fire of mountain broom.

At sunset it suddenly abated, and two hours after there was a calm, occasionally interrupted by violent gusts of wind, which rushed along with a noise like distant thunder in a mountainous country.

After partaking of a supper of hot coffee, bread, and roasted potatoes, we made a trench in the pumice, in which I placed my guide and muleteer, and then covered them up to the neck with light pumice-dust, over which I put my cloak. This simple plan so effectually protected them from the bitter cold, that I soon found they had forgotten all the fatigues in a sound slumber.

As I wished to note the barometer and thermometer every hour, and had agreed with some friends at Port Orotava and the Villa, to observe them at the same time during part of the twenty-four hours, I was unable to take the rest which I so much required. The strange and interesting scene around me caused a feeling which partook in some degree of pleasure and pain; not having anyone to whom I could express my feelings, produced a painful void. The peculiar wildness of the scene was in some degree enlivened by the splendour of the starry vault above, which was so extremely blue, that if it had been seen in a picture, it might have been thought unnatural. From the clearness of the atmosphere, the light given by the stars and planets was sufficient to enable me to write my observations, and Venus left a faint glimmering streak of light on a wreath of snow close to our resting-place; and when the moon arose, I could distinctly see the degrees on my instruments. A still stronger proof of the extreme clearness of the atmosphere was, that I observed the moon to be indented like a saw, between the light and obscured part, which I supposed was caused by the projection of the illuminated tops of the mountains upon the part which was deprived of the sun's light.

Soon after dark a broad pyramidal body of light appeared, like the glow on the sky caused by a distant conflagration; this was the zodiacal light; where there were openings in the clouds below, the brightness continued close down to the horizon, with as deep a tone as that of the zenith. It was much broader below, occupying a space equal to what I considered to be nearly 15° in breadth. Orion was so clear, that if I had had a telescope of even moderate power, no doubt I might have seen the whole of his sword.

Another phenomenon I observed may be worth mentioning. Soon after the sun went down, the wind became much louder and had an acuter sound, although the force was very considerably less than it was before. It has been observed, from the earliest antiquity, that the air becomes more sonorous at night than in the day, but I am not aware that the cause of it has been well ascertained. The general opinion is, I believe, that the air, becoming colder, is therefore denser, and more susceptible of conveying the sonorous waves. Our navigators to the North Pole have frequently mentioned the surprising distance from which they were enabled to hear sound during an Arctic winter. My observations of the intensity of sound at different states of the atmosphere were not confined to the Peak. At the town of Orotava, situated about two miles from the sea, the noise of the waves in the morning occasionally had a grave, low tone; at the same time, the air appeared to be particularly *dry*, and distant objects were very indistinct. Towards the middle of the day, or the beginning of the afternoon, and when the difference between the dry and wet bulb thermometer was *less* than usual, the island of Palma, nearly sixty miles distant, could be distinctly seen, and the mountains that surround the valley of Orotava were brought apparently so close, that the vegetation upon them could be observed; at the same time, the sound of the sea invariably passed from a grave to an acute sound. The natives prognosticate rain when they observe this particular clearness of the atmosphere, and generally I have found them correct. I have made the same remark during my long residence in Chili, where the distant Andes are apparently only a few miles off shortly before rain, and the noise of the waves of the sea, dashing on the rocky coast, assumes a different tone.

From frequent observations that I have made, I am inclined to attribute the intensity of sound at night to a certain increase of moisture, and to an *equability* of temperature in the different strata of the atmosphere. The increased intensity of sound when I was on the Peak during the night could not have been caused by an increased density of the atmosphere, because, instead of becoming colder, it was four or five degrees warmer when the sound of the wind became more sonorous.

The instruments were observed every hour, and the boiling-point of water was noted four times, giving an average of 193°·64; the barometer, an average pressure of 20°·329. This boiling-point does not exactly agree with the experiments of General Roy, who considered that the boiling-point of water varied 0·88 of a degree for every half-inch of a variation of the barometer At the Villa de Orotava, at an elevation of 1,141 feet, I found the average boiling-point to be 209°·178,—the thermometer was not in the water, but close above it. In the subjoined table I merely give the result of my observations at such times as there were notable differences. The difference of radiation was most astonishing: as night approached it fell 80° in an hour; at midnight it was negative, that is, the shaded thermometer was 9° *higher* than the exposed one. At first I thought it must be caused by local position, but I removed the thermometers three times, and found the results similar. I was surprised to find that, at the moment of sunrise, it was still negative, the shaded thermometer standing 4° higher than the other. At Alta Vista de Arriba, one hour and a half after sunrise, the black-bulb thermometer rose to 98°, and later to 126°.

The following table is the result of my observations made at La Estancia de los Ingleses, 9,930 feet above the level of the sea:—

Hour.	Sheltered Thermometer.	Black-bulb Thermometer.	Dew-point Depression.	Boiling-point of Water.	Barometer.
1.0 P.M.	50	195	46	193·65	20·334
3.30 „	42	190	45	193·62	20·330
7.0 „	36	39	40	193·61	20·327
Midnight.	38·5	29·5	31	—	20·324
2.0 A.M.	38·5	27·5	30	—	20·323
5.0 „	36·5	32·5	35	—	20·331
Noon.	66	212	60	193·68	20·336

About an hour before sunrise I awoke my sleepy men, but my guide (who had never ascended to the top of the Peak) was seized with an affection like sea-sickness, and a violent pain in the head, no doubt caused by the rarity of the air, therefore I was obliged to leave him at the Estancia to await my return.

In an hour we reached that part of the Peak directly above Alta Vista de Arriba, called Mal Pais (bad country), 10,730 feet above the sea. The part we arrived at was well named Mal Pais, as it was formed of immense masses of trachytic lava, thrown about in all imaginable shapes and directions, interspersed with large blocks of obsidian, some of which were like enormous bomb-shells; one or two small ones that I broke were hollow in the centre; the internal cavity was lined with thin filaments, similar to those found in flint nodules; the edges of some of the masses of obsidian were often as sharp as those of broken wine-bottles. The blocks of lava were sometimes wide apart, and sometimes had mere slits between them, but always wide enough to swallow up a pencil if one were dropped in. Some of the lavas looked as if they had run down the Peak in a half-fluid state, and had broken into detached masses in cooling.

We had made our ascent up to this point by the lights of the spangled vault above, but it was impossible to proceed any further until daylight. We had not long to wait; in a few minutes a long and bright streak of light orange-colour began to tinge the eastern part of the fleecy clouds below; it then deepened into a rose-colour, which was reflected on the cone of the Peak just above us, and then followed such a magnificent blending of colours as to defy description, and the day-break rapidly chased away the darkness in the plain below. The cold was most penetrating; the thermometer stood at 21°, which was 13° below what it had stood at, at any time during the night, only 800 feet below.

We again resumed our ascent, which over these rough masses was difficult and painful, as we were obliged to jump from block to block, aided by a long staff shod with steel, and occasionally to climb over some with the hands and feet. The greatest annoyance we experienced was from thick masses of snow between the blocks of lava, which had frozen hard, forming a surface like glass, thus making it extremely difficult to cross, particularly as I was unprovided with proper shoes. The thermometer soon rose to 34°; this sudden rise of temperature, combined with the great exertion of climbing, made me feel my overcoat oppressive, and I was glad to leave it, till my return, under a high block of obsidian. After some fatigue, we reached a spot called the Cueva de Nieve (*the cave of snow*), which is 11,098 feet above the level of the sea. At 7 A.M. the thermometer stood here at 42°·75, the barometer at 19°·912, and water boiled at 192°·78.

This singular cave is always filled with ice and water; the entrance is merely a hole in the trachytic lava, about 40 inches square, and from 18 to 20 feet perpendicular depth; as I was not provided with a ladder, my man let me down by fastening a rope round my waist. I found the floor immediately below the entrance was formed of rough blocks of lava; there were three branches or lanes, the principal one, which I more particularly observed, was 60 to 70 feet long. Round the walls was a band of ice about 7 feet wide and 3 feet high, completely surrounding a little pond of water which did not exceed 2 to 3 feet deep near the mouth, but at the farther extremity I could not reach the bottom with my mountain staff, 8 feet long. At the farther extremity was what the *neveros* (ice collectors) call El hombre de nieve, the man of snow; on close inspection it proved to be a honeycombed mass of lava, on which the water had dripped from the roof, and had frozen into what might, in the obscurity of the place, be thought to resemble a human figure. I think the sides of the cave show that it has been a crater of emission, for the surfaces are rounded, as if they had been acted on when in a plastic state. I was further confirmed in this opinion by observing a short distance below the cave a stream of lava, which had evidently not flowed from the Rembleta above. Some of the lava had a wrinkled or corrugated appearance, as if it had issued out in a half-fluid state, and had rapidly cooled as it trickled forwards by its own weight. It was extraordinary that the water could be retained in this basin of porous lava, but I think that the surface of the bottom had been glazed over in a similar manner as the sides, by the action of heat; besides, it was covered over with a bed of ice, on which the water rested; this was evident, as wherever I plunged my pole, it struck on ice. The ice-collectors I employed during my first attempt to ascend, assured me that they had often seen smoke or steam issue out of the cave, but I saw neither when I was there.

In three quarters of an hour after leaving the cave we arrived at a small plain of pumice, called the Rembleta, situated 11,721 feet above the sea; this plain appeared to have been the ancient crater of the Peak, from which most of the currents of lava had proceeded previous to the formation of the present cone, or *Pilon* (sugar-loaf), which rises nearly in the centre of this plain to an elevation of 479 feet. The foot of the cone was encircled by water entirely frozen over; it was no doubt derived from the snow which fell on the sides of the cone melting, which thus formed the narrow belt of water around it.

Although the actual elevation of the cone was small, yet I found the ascent the most difficult and fatiguing part of the journey. The surface is a light pumice and ash, with small pieces of porphyritic lava covered with an ochreous crust occasionally protruding through it. Some idea may be formed of the steepness of the cone when I mention that at the bottom the slope forms an angle of 35°, gradually increasing till, near the top, the angle is

42°, which is nearly the greatest angle the body can ascend in walking without falling backward. The pumice and ashes gave way under my feet, and often caused me to slide back many yards before it was possible to stop myself, then I was arrested by some of the protruding pieces of porphyritic lava. In forty minutes after leaving the Rembleta, I seated myself on the highest pinnacle of the Peak, 12,200 feet above the level of the sea.

The Peak is a solfatara, that is (see Plate II.), a half-extinguished volcano The crater is much smaller and more shallow than I expected; round the summit runs a wall of porphyritic lava of an elliptical form, about 150 feet long, 100 broad, and 50 deep; the surface of the lava was coated with a soft white mass like dough, caused by the sulphurous acid vapours having acted upon the argil of the lava, and turned it into a sulphate of alumina. As I only paced the crater once for the purpose of measuring it, I am not certain that the dimensions I have given are perfectly correct. The bottom of the crater was unpleasantly hot, and the air so filled with vapours of sulphurous acid that I was continually sneezing, and the lungs felt sore and pained. The surface was covered with most beautiful trimetric crystals of sulphur, some of a yellowish white, others of a reddish and greenish colour. In some little caves, only a few feet deep, were some small apertures covered with splendid crystals of octahedral sulphur; on breaking some of them, I found in the interior a glistening white substance something like opal, only that it had a crystalline structure; on my return to England it was analyzed, and found to contain 91 per cent. of silex, and the rest water. The pasty substance on the surface of the lava, proved to be sulphate of alumina, muriate of ammonia, and a small quantity (0·5 per cent.) of sulphate of ammonia. Round the walls of the crater were several small apertures, like small pipes, about an inch in diameter, some of which were emitting steam, and others sulphurous acid vapours, which show that they must have proceeded from different sources, although some of the holes were only a few inches apart. The heat of the steam was considerable, for when I placed a thermometer graduated to 133° within their influence, the bulb burst.

The extreme dryness of the atmosphere and the radiation of the sun's rays were distressing; the lips cracked; the nails became brittle; the mahogany box, containing a Daniell's hygrometer, became unglued, and the case of a small pocket-sextant split across. The evaporation of the wet-bulb thermometer was so rapid that it was necessary to watch it closely, otherwise the muslin would be dry before the observation could be made.

The basaltic lava and the trachytes of the Peak were magnetic and had polarity, but I had no means of measuring it.

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John Steeple, del[t] (from a Sketch by R.E. Alison.) M & N Hanhart lith.

THE SUMMIT (Crater) 12,[illegible],
above the Sea level.

The following were the observations made on the wall surrounding the crater, and a few feet below the highest point:—

	Sheltered Thermometer.	Black Bulb Thermometer.	Dew-point of Depression.	Boiling-point of Water.	Barometer.
Noon . .	54°·25	200°	62°	191°·125	19°·093

Although the atmosphere appeared perfectly clear, yet when I looked across the sun's rays from the shade of a rock, there was an evident dust-haze, probably brought over by the wind from the neighbouring desert of Africa.

The view from the top was most magnificent, the masses of cumuli, which had been resting at an elevation of 5,000 feet above the level of the sea, had entirely disappeared; with the exception of the islands of Forteventura and Lanzarote, the whole of the Canarian archipelago seemed to be close under my feet, the mountains of Grand Canary appeared as if on the island below, Palma 46 miles distant, and Gomera with Hierro were quite distinct.

I think it must be allowed that the Peak is a volcano of eruption, but there are strong evidences that it is nearly surrounded by a more ancient and enormous crater of elevation, termed the Cañadas, which form an atrium 23 miles in circumference.

The Cañadas are surrounded by cliffs of lava, varying from 540 feet to about 1,000 feet high; the plain of this crater is 4,383 feet lower than the mean elevation of the cone of the peak, which rises like a great mole-hill *nearly* in the centre of this atrium. From the cliffs of this atrium, various ridges of mountains spring out like the spokes of a wheel; some of them rise to an elevation of 8,950 feet, such as the Risco de Guajara, which is part of the elevated chain of mountains surrounding the Cañadas from the E. to W.S.W. These ridges of mountains, forming as it were buttresses, have radial valleys between them, running for some miles towards the sea.

As you pass over these currents and mountains of lava, the view is so bewildering, that it requires two or three visits before you can understand the system of these volcanic mountains, which can be done only by making a preliminary observation from a very elevated position, so as to take a bird's-eye view of the whole island, and then making more observations in detail on foot.

These various mountain ridges have all the appearance of having been at one time joined together, for when I examined their respective strata I found that they intercalated in the same manner; for instance, No 3 stratum in one ridge would be of the same type as No. 3 in an opposite one, though they were some miles apart.

Some idea may be formed of the great antiquity of the streams of lava that run towards the sea, by a careful examination of the large ravine which I have already mentioned as having been formed by a waterspout in November, 1826. In some parts of it, I counted no less than 75 various layers of lava and vegetable earth; some of the layers consisted of compact basalt, trachytic porphyry, and phonolite, between some of them were layers of vegetable earth three and four inches thick, with fine roots of plants turned into charcoal. Sir William Hamilton found that it took several centuries before the compact lavas of Vesuvius became covered with a thick layer of vegetable earth, here were various strata with layers of earth between them, showing that ages must have elapsed between some of the eruptions.

The question naturally occurs, Is there any probability of such eruptions occurring again? The crater of the Peak emits smoke and steam at intervals all the year round; after heavy rains I have often seen the crater throwing up dense columns of steam; as a proof that the fires are not far below, when I thrust my staff a few feet into crust of the crater, and withdrew it, I could not touch it, as it was quite hot.

In 1797, the town of Garrachica was entirely destroyed by an eruption from the volcano of Chajorra, which is about 2,000 feet lower than the top of the Peak, but whose crater is nearly a quarter of a mile in diameter. The Port of the unfortunate town was entirely filled up, and you now see churches, convents, and houses without roofs, and the walls protuding a few feet above the solid mass of basaltic lava. But the eruption of that year must have been a mere nothing in comparison with those of the distant times when the whole island was covered with liquid lava, forming the high cliffs which now guard its shores, and when masses of obsidian, many tons in weight, were launched into the air like huge volcanic bombs, some miles from the volcanic vent.

It may be interesting to know what is the best time of the year to ascend the Peak; from the experience I had from my frequent ascents to the Cumbre, at an elevation of upwards of 7,000 feet, I observed that the seasons above were much earlier than they were below, consequently the latter part of the spring is the best season to visit the Peak. While August and September have a mean temperature of nearly 73° at the Villa de Orotava, 1,141 feet above the sea, I found it was cold in the *shade* at an elevation of between 7,000 and 8,000 feet, with an extreme radiation and distressing dryness. During the latter part of the autumn the cold is most intense at night above, even much greater than during January and February, when the cold even on the summit of the Peak is far from excessive. When I ascended the Peak in October to an elevation of 10,700 feet, I found the cold greater than it was in February. I am aware that this is against the generally received opinion, but I give merely the result of actual experience and of numerous observations I made during my residence at Teneriffe.

From various observations I made at different elevations in Teneriffe, it is evident that the decrease of temperature is more rapid in the inferior strata of the atmosphere, and slower in the superior, but at a certain elevation (which possibly varies according to the latitude) the temperature in the summer season is almost stationary throughout the twenty-four hours; even in winter, during the middle of the day at the same elevation, and in Teneriffe the height of this stratum of air is from nine to eleven thousand feet.

If the decrease be uniform, the mean temperature of a certain elevation will be found by a thermometer placed between the lower and upper stations; but this is not the case, the error being much larger when taken in arithmetical, than in geometrical progression.

The temperature at Port Orotava was . . .	61°·5
That on the top of the Peak at the same time .	45°·875
Difference between the two stations . .	15°·625
If the temperature had decreased in arithmetical progression, that on the top ought to have been .	—15°·94
Or a difference between the two of . . .	77°·44
Instead of which I found it to be only . . .	15°·625

The following figures will show the difference of temperature per 1,000 feet: the difference of temperature between Port and Villa Orotava gave 5°·726 as the average difference per 1,000 feet of elevation; while between the Port and the Estancia de los Ingleses the average difference of temperature per 1,000 feet was only 2°·43. Taking the difference of temperature between the Villa Orotava and the Estancia de los Ingleses, it would be necessary to ascend 537·75 feet for an alteration of one degree of temperature, but between the Villa and the summit of the Peak, it would be necessary to ascend 1,317 feet for one degree of difference in temperature.

It is, however, impossible to know the exact temperature of any point by a single passing observation, as the thermometer may vary every moment according to the presence of the sun, the interposition of the clouds, a strong wind, or a calm; a level fog may occasion a refrigeration in that part of the atmosphere where the instrument is situated, which the rest of the air may not partake of; and any of these accidents may occur at the precise moment of observation. These can be all allowed for to a certain degree of correctness, but the immense difference between the supposed and observed decrement of heat, from the sea-coast to the top of the Peak, cannot be attributed to the effect of local causes, but must be ascribed to the incorrectness of the theory; and although it may never be submitted to accurate calculations, from the variety of disturbing causes, yet it may be brought to a near approach to truth.

Much has been done of late years by the intrepid and meritorious Mr. Glaisher in his ascents in a balloon, which have thrown much light on this subject; but it is much to be desired that some learned society would pay attention to this problem, and resolve it through direct and frequent observations; by establishing on the Peak a set of observations throughout the year: although it is covered with snow every year for the space of six or eight months, yet the cold is nothing to compare with that of the polar regions.

By means of a balloon, the experiment could occasionally be made, and with it the numerous local variations, now to be feared, would be entirely obviated.

II. THE CATTLE PLAGUE.

It is but a short history and description that can be placed on record here of the epizootic disease which has latterly decimated the herds of many of the Eastern Counties; for nothing has yet been discovered or devised capable of effecting the cure of this deadly disorder. The few instances in which cures have been alleged are given on doubtful authority, and the general experience hitherto has been that the percentage of recovery is as large in the cases of cattle receiving no special treatment whatever as in that of animals in the hands of the energetic medical man. We can thus do little more than relate the history and nature of the attack and of the measures, hitherto unavailing, which have been taken to meet it.

The disease was first noticed shortly after Midsummer in the north London cowhouses. The first animals that died were English cows which had been purchased at the Metropolitan Cattle Market. Three weeks before this purchase part of a cargo of Russian cattle landed at Hull—the first, it is said, that had been imported direct from Russia into this country—had been sold in the same market. Russia is the home of the rinderpest, and although the particular province from which these animals were imported has been declared entirely free from the disease in question, and notwithstanding the very long interval between their shipment at Revel and the outbreak on June 27th in the Islington cowhouse, and the fact that no mischief has been traced from the remainder of the cargo which left Hull for the Western Counties —it is declared and believed that to these Russian cattle we are to attribute the calamity which has befallen our stock owners, and especially the Edinburgh and London cowkeepers. These foreign cattle have introduced a new and specific poison into this country, which has spread with unexampled rapidity and virulence, destroying upwards of ninety per cent. of the animals in which it has become developed. This is the prevalent theory on the subject. There are, indeed, many who believe that our cattle plague is no new disease, but only the aggravation of an old-standing malady produced by the weakened condition of our live stock, owing to the hard summer and winter of 1864, and their subsequent indulgence in the luxuriant "keep" of the spring and summer of 1865—under the circumstances of the miserable crowding and confinement of town cowhouses. But they fail to account for the altogether unique virulence and destructiveness of the attack, and they assume without foundation that there were the same difficulty and difference in feeding the town-kept stock as were experienced in the country during the dry year 1864, which preceded this attack.

The London cowhouses are no doubt, many of them, disgracefully close; and the cattle are kept in an unnaturally excited state by food and warmth; but their condition has been improving of late years, and whereas formerly no supervision whatever was exercised, now that every cowkeeper must annually renew his licence, the justices are every year insisting on more stringent provisions for their regulation. In St. Pancras, when licences were first required, 600 cubic feet of space were insisted on for every cow. Since then the measure has been raised to 800, and latterly to 1,000 cubic feet per cow. In a cowhouse 16 feet square by 7 feet high—a cellar (open to the yard) beneath a dwelling-house—which we visited the other day, they used to keep ten cows! When first a licence was required the number was reduced to two, and now the licence is, very properly, altogether refused in this and every other case of cowhouses in or under dwelling-houses. We mention this in illustration of the improvement which had been witnessed in the condition of the London cows before the advent of this attack, which cannot, therefore, be attributed to the aggravation at this time of any long existing mischief in their management.

The Cattle Plague is, indeed, no new thing—not even in England—for the records of last century prove that a distemper equally sudden in its advent, and equally destructive during its continuance, attacked our herds in 1745–1757. To quote from the recently published report of the Royal Commission on this subject: "There is every reason to believe that the distemper which in 1715 made a brief inroad, but was promptly expelled, and which in 1745 renewed the attack and held its ground till 1757, was exactly the same as the present plague. Of this we have proof in the descriptions extant of the symptoms then observed, and of the morbid appearances after death. In a paper communicated to the

Royal Society in January, 1746, by Dr. Mortimer, he ascribes the origin of the murrain to two calves imported from Holland by a farmer living near Poplar, early in 1745. The spring and summer had been very wet, the autumn dry and cold, the early winter cold and damp. The disease communicated to the cows of this farmer spread through Essex, reached London, and was propagated in various directions from the metropolitan markets. The disease for some time advanced in a manner which appeared to justify the Government in treating its attacks as mere local outbreaks, and it was nearly a year after its first appearance that the country became sufficiently aroused to use national measures for the repression of it."

It has, moreover, been constantly more or less destructive in the Southern Provinces of Russia, where, indeed, they try to confine it by a rigid quarantine maintained between them and the neighbouring countries. Though not so destructive in its proper "home," it has proved extremely fatal wherever it has broken bounds and infected the previously untainted herds of Western Europe. Thus the report of the Commission already quoted informs us that "the Danish monarchy, in the four years from 1745 to 1749, lost 280,000 head, and Holland, in the three years begining with 1769, lost 395,000 head. These disasters attracted the attention of Governments and scientific men, and the long peace which began in 1816 permitted the adoption of those careful and systematic measures of precaution which, in the countries bordering on Russia, have been maintained ever since with various modifications, and, on the whole, with considerable success. It was ascertained that Europe usually received the infection through Russian steppe cattle sent into Poland and Hungary. Large herds of them are annually driven to different parts of Russia, to Poland, Galicia, and Hungary, and often carry with them the seeds of disease in their train. In 1862 the number attacked by the plague in the Austrian dominions was 296,000, of which 152,000 died. In 1863 it again invaded and overran not only Galicia, but the whole of the kingdom of Hungary and its dependencies, the Bukowina, Dalmatia, Carniola, Lower Austria, Moravia, and Styria." Fourteen per cent. of the cattle in these countries took the infection, and the average mortality, as stated in Schmidt's *Jahrbuch der Gesammten Medecin*, 1865 (p. 95), was as follows:—

	Per cent.		Per cent.
Hungary	65	Military Frontier	83
East Galicia	77	Moravia	88
Croatia and Slavonia	81·6	Lower Austria	92

That the disease which has thus been so constantly the terror of Eastern stockowners is the same which is now so destructive here, is proved by its symptoms. These are thus described by Dr. Smart, of Edinburgh:—

"1. *Period of Incubation.*—This is the latent period of the disease, beginning with the reception of the poison by the animal, and terminating when the symptoms of its development in the system become apparent. The duration of this period has been variously stated, but all my observations lead me to conclude that it terminates on the seventh day, by the outward manifestation of distinctly recognizable indications. These are—

"2. *The Earliest Recognizable Symptoms.*—They are enumerated as nearly as possible in the order in which they appear. 1. Loss of appetite. This shows itself (1) by an aversion to all sorts of 'green' food. The next day or the following there is (2) indifference to food of any kind. The animal still eats, but languidly, does not lick out the pail, or leaves a portion of the meal, and soon thereafter refuses food altogether. She now ceases to chew the cud, and from this time there is commencing constipation, with progressive diminution of the milk. She looks depressed, stands much in the same posture, with drooping head and reclining ears. The ears, horns, and other extremities are now sensibly under their natural temperature. The breathing is yet but slightly accelerated, and the expiration (or outbreath) perceptibly prolonged, and the pulse rises a few beats in frequency. It is at this period the orifice of the vagina reddens, and the colour deepens as the disease advances. This appearance of the vulva is the most characteristic and trustworthy mark of the disease at this stage. A faint red or purple line about the same time appears on the undergum along the roots of the teeth. All these symptoms concur within a day or two of the incubation period. The diseased condition of the internal organs after death clearly points to this and the preceding period of the disease as the proper time for successful treatment, before destructive changes have too far advanced.

"3. *More advanced Symptoms.*—The breathing is now more accelerated, oppressed, sighing, and laborious. The number of respirations varies generally from 36 to 70 per minute. The pulse is more rapid (from 60 to 110 pulsations per minute) and weaker. There is continued loss of appetite, constipation, and thirst. The superficial membrane of the mouth, especially of the inner side of the upper lip, roughens, and a viscid discharge appears in the vagina. A similar appearance is seen on the membrane of the vagina where it joins the skin. The milk is scanty, and entirely changed to cream, or there is none at all. All the other symptoms are more decidedly pronounced. The likelihood of recovery is greatly diminished by delaying treatment to this period.

"4. *Most advanced Symptoms.*—They are those which shortly precede death, and are unattended by any very marked outward signs of pain. The breathing is now slow, very laborious, and moaning or grunting. Pulse slow and small. Where purgatives have not been given there is great distention of the abdomen, and obstinate constipation. The fluid and sometimes sanguineous discharges from the bowels, which occur in some cases, are the results generally of the too frequent use of irritant drugs. The superficial membrane of the mouth peels off from the gums and lips, leaving the surface raw; and frequently, but not invariably, there is a viscid discharge from the eyes, nostrils, and vagina. The animal now dies without a struggle, apparently from simple exhaustion.

"The 'staring hide' and 'arched back,' so frequently mentioned as distinctive features of this disease, while characteristic of the advanced forms of pleuro-pneumonia, are not at all marks of the rinderpest. There is no cough or lung symptom in the pure and uncomplicated examples of the disease."

The loss of appetite is a first symptom of many other diseases besides rinderpest; nevertheless such is the dread of the cattle plague, that in the London cowhouses, where it is the invariable custom to fatten cows towards the close of their milking, and to keep them throughout the period in tolerable condition for the butcher, it has latterly been almost universally the practice to slaughter a cow as soon as she goes off her feed. Her carcass will pass inspection at market, whether the earliest appearances of the plague (patches of inflammation on the mucous membrane of the fourth stomach, and longitudinal and transverse streaks on the membrane lining the small intestines) have been developed or not. And though the idea of such meat entering our markets for consumption in any quantity is not very agreeable, yet it is declared that while the disease is thus still in or only just passing out of the incubative stage, the flesh of the animal is perfectly wholesome. The owner thus prefers the loss in part which he sustains by the sale of a milk cow to the butcher, to the total loss which, if she prove to have the plague, he is certain to incur, for the treatment of the disease has hitherto been ineffectual. Some such remedy as Dr. Smart recommends,* common enough, indeed, as a drench well known to herdsmen, of which the main ingredients are sulphur

* Dr. Smart's dose for a cow, in the earlier and later stages respectively of the malady, is as follows:—"There are only three kinds of drugs which I found it requisite to employ. 1. Laxative, with diuretic action. This is principally used in the early, but often required at other periods, in the progress of the disease. It is composed of—

Laxative.

Nitrate of potash } of each 1 oz.
Powdered ginger }
Powder of sublimed sulphur, 2 oz.
Treacle, 1 lb.
Water to make a quart, and well mixed.

This quantity is given night and morning, or, if requisite, oftener, until scouring is produced. Afterwards an occasional bottle will maintain their free, without excessive, action.

As the vital powers sink rapidly, there should be as little delay as possible in and nitre (laxative and diuretic), combined with warm clothing enough to make the animal perspire profusely, so that skin, stomach, and kidneys are all excited to unusual action, with the view of getting the poison out of the system, is advisable in the first stage of the attack. And the earlier the symptoms can be perceived and recognized, the better the small chance of success in the treatment of the case.

In spite, however, of treatment, a herdsman finds a cow or two, that may have been off their feed for a day or two without exciting much observation, suddenly displaying one after another the train of symptoms which we have quoted from Dr. Smart; and if he does not at once get rid of his herd, in a very few days or weeks the plague runs through the whole of them, and not five per cent. of them survive. Whole herds have thus been lost. Lord Granville's herd, near Hendon, was one of the earliest. A neighbour had lost some cows by the disease, and the contagion in some unexplained manner reached his lordship's byres, and nearly all the cows died under it. Calves bought in the Metropolitan Market and sent to Norfolk, Essex, and Sussex, carried the contagion with them, and forthwith whole herds disappeared. A London cowkeeper finding something wrong with his herd in town sends them all over to his farm near Guildford, and forthwith the whole district there is infected, and one and another lose their all.

The disease is unquestionably more virulently contagious than any other known, though there is still some doubt whether it be capable of transmission to any other kind of animal. Mr. Harvey's flock of sheep at Crown Point, near Norwich, was indeed struck with an extremely fatal disease, very much resembling the cattle plague in the symptoms during life, and in the appearances after death; and this happened very soon after the herd on the same estate had suffered from the rinderpest; but, on the other hand, the experiments

administering stimulants. I have found the following mixture, possessing stimulant, diuretic, and diaphoretic properties, very efficacious :—

Stimulant.

Carbonate of ammonia, ¾ of an oz.
Sweet spirit of nitre, Spirit of mindereris } of each 1½ oz.
Cold water, 9 oz. Mix.

This dose, from the commencement of treatment, is administered thrice a day during the entire course of the disease. When prostration is great it is sometimes needful to conjoin it with the laxative given along with all other medicines. In such cases the doses are smaller.

When convalescence is fully established, a simple tonic hastens recovery. I find none so good and safe as cinchona bark. The best quality only should be used, and given in doses of 1½ oz. of the powder.

This tonic in the early period of convalescence is combined with the stimulant, and at a later period with a quart of good sweet ale given once daily. It is best administered at night. With the exception of an occasional dose of laudanum (two tablespoonfuls to any medicine the animal is getting, or in the food), to obviate straining and control excessive diarrhœa, no other drugs are used."

at Edinburgh, in which healthy sheep had been kept for weeks in the sanatorium where diseased cattle were under treatment, seemed to show that the disease was not communicable.* In an address on this subject to the Wayland (Norfolk) Agricultural Society, Mr. Woods, of Merton, an undoubted authority on sheep management, discussed the whole history of the Crown Point flock during the past summer, and gave it for his opinion that the disease which had been so fatal among them was not the rinderpest; and we learn from him that on large Russian estates, where flocks and herds are pastured together, the former are not liable to the disease which destroys the latter.

There is no doubt, however, that it is wonderfully liable to spread among cattle when once a case has happened. The reports to the Privy Council by the veterinary inspectors recorded that from 1,000 to 1,800 cases a week occurred during the three weeks ending October 28th, and there cannot be a doubt that in a multitude of instances the veterinary inspection is altogether evaded. The cases reported were chiefly in the metropolitan district and in the southern and eastern counties and in Scotland; and of the 17,673 cases altogether up to the end of October only 848 recovered.

The measures taken by Government within the powers conferred upon them by a recent Act of Parliament, have been confined to the appointment of veterinary inspectors, with power to enter premises and direct the slaughter and the burial of infected animals —the infliction of penalties upon anyone selling from a diseased herd without the inspector's permit, and in a few cases an enforced imprisonment of the livestock of a particular district or province within the boundaries of that district. That this has proved insufficient is plain from the progress of the disorder; and her Majesty's Commissioners, to whom an inquiry into the whole subject was remitted, have at length reported by a majority of their number in favour of an enforced entire cessation of movement in cattle (except within their several farms) throughout the kingdom for a sufficient period; leaving the markets to be wholly supplied by dead meat. A very influential minority of the Commissioners, however, do not believe that this is possible, and therefore unite with their colleagues only in the alternative measures which they advise in the event of the severer recommendation being refused. The measures thus indicated are included in the following particulars:—

"*a*. For a definite period no lean or store stock should be permitted to be sold at any fair or market, or in any other manner whatever.

"*b*. Cattle might be moved for immediate slaughter to a market or to a slaughterhouse licensed for use, but only under a licence for

* It has been since announced, that sheep inoculated from diseased cattle have died with all the symptoms of rinderpest.

transit. With this exception, and except cattle driven from one part of the same farm to another, the transit of cattle should be absolutely prohibited.

"*c.* Precautions should be taken that every animal sold for butcher's meat be slaughtered within a short and fixed period. Cattle sold at a fair or market should not be allowed to leave the precincts of the place alive.

"*d.* It would be desirable to draw some more distinct line between infected and uninfected districts than is at present traced by the orders in Council. The egress of live cattle from a proclaimed district should be strictly prohibited, but cattle slaughtered within it and certified by the district inspector to be fit for food might be sent out of it."

These, then, are the measures which the Royal Commissioners recommend, and which Government will, in all probability, adopt, in order to confine the disease to the particular herds in which it exists, for long enough to ensure the destruction of the poisonous contagion.

It is to be hoped that when that event shall happily have arrived, a much severer inspection of imported cattle will be instituted at the ports of departure and arrival than has hitherto been possible. We conclude with the review of the subject which the report of the Commissioners contains:—

"The cattle plague is, in the language of medicine, a specific disease, belonging to the class of contagious fevers. The contagious matter is subtle, volatile, prolific in an unexampled degree. It is conveyed in a most virulent form in the excretions from the diseased animal. Any particle of those excretions may serve as a vehicle for it. We know not the limit of time within which it disengages itself from them, nor to what distance it may not be diffused. It may travel, we know, in the hide, horns, hoofs, and intestines of the dead animal; the offal, therefore, is highly dangerous. It lurks undeveloped in the system for a period about which some difference of opinion exists, which certainly is not less than five days, usually seven or eight, but appears to be more prolonged in some cases. Towards the end of this period of incubation, but at what precise point we do not know, it becomes capable of diffusing itself by contagion. A diseased animal may, therefore, be infectious before it shows any signs of disease, or, at all events, before the malady betrays itself to any but a very close and very skilful observer. The proportion of cases in which it is fatal is extraordinarily large. No specific has been discovered which neutralizes or expels the poison; judicious treatment may enable nature to resist till the virus has spent itself; injudicious treatment may have a contrary effect; but that is all. The practical conclusion, therefore, at which foreign physicians and foreign Governments have arrived,—the conclusion that it is better always to kill a diseased animal, or a few diseased animals, where by so doing you can kill an isolated germ of disease instead of suffering that germ to linger and fructify while you are attempting a cure, for the precarious prospect of an insignificant saving,—is justified by reason; it is also directly justified by experience, which shows that while the plague, propagated from a single germ, speedily becomes unmanageable, spreads from herd to herd, from province to province, and from country to country, multiplies in a continually increasing ratio, and exhausts itself only after ruinous havoc and a long course of time, it may be effectually eradicated by prompt and unsparing measures. The experience of Prussia is especially valuable in this respect. The plague has often appeared, says Professor Gerlach, in the provinces bordering on the Russian empire, in East Prussia, Posen, and Silesia, but it has never since 1815 penetrated eastwards, even so far as Brandenburg. Lastly, we must add, it has not been found to give way before cold weather or rain. The reverse seems to be the case. It is worse, Professor Gerlach informs us, 'in cold and wet weather, and better in warm and dry weather.' 'It spreads,' says Mr. Ernes, 'as fast in a cold as in a hot season.' The murrain of 1745 broke out here in early spring, the temperature of the preceding year having been low; and it is stated to have raged most violently during the winters, and to have diminished in intensity with the advance of summer.

" These conclusions, which are all that for our present purpose it is necessary to state, are far, of course, from exhausting all that is known upon the subject. Beyond what is known, however, there is a large field of inquiry which may be usefully explored. To observe carefully the premonitory and progressive symptoms of the disease under various conditions—to determine precisely the period of incubation, the effect of remedial and of preventive agencies (including under the latter head disinfectants, therapeutical measures, and inoculation)—to ascertain within what range and under what modifications the poison may be communicated from a diseased cow to other animals of the same or different species—these are branches of investigation practically important, but which will take time. With a view to the thorough examination of them, we have obtained the assistance of men eminent in various departments of science, and we hope to be able to report on them hereafter. But we have now to deal with more pressing questions. Are the measures hitherto adopted to stifle the plague at home and stop its entrance from abroad effectual for the purpose? If not, what other measures are likely to be effectual? To these questions, having early satisfied ourselves of the general character of the disease, we at once directed our attention; and the evidence which we have received has been chiefly taken with a view to them."

III. ON THE RECURRENCE OF SPECIES IN GEOLOGICAL FORMATIONS.

By A. C. Ramsay, F.R.S.

The paper by Mr. Jenkins in the last number of this Journal, "On Strata Identified by Organic Remains" (an article which I have read with interest, and the value of which I appreciate), induces me to publish this brief communication with a view to point out that it seems to me that some of Mr. Jenkins' arguments may lead to a total misunderstanding of the reasoning employed in my anniversary addresses to the Geological Society in 1863 and 1864. My chief object in these addresses was to show the connection between unconformity and the partial or complete change of marine faunas during times unrepresented by strata, and in discussing the question whether (as had been asserted) a Silurian, a Devonian, and a Carboniferous fauna might all coexist in different areas, I stated if it were so, "that in the piles of formations" of Europe and America, "the chances are overwhelmingly strong, that in each or in some one area there might be a *recurrent fauna*, which is not the case."

Mr. Jenkins quotes the foregoing passage, and a little lower in the page he points out that I refute myself in my own address, because in discussing the Lower Oolites, I state, that "the majority of the forms that passed upwards from the Inferior Oolite limestone seem to have fled the muddy bottom of the Fuller's-earth sea, and to have returned to the same area, when the later period of the Great Oolite began." "Here," says Mr. Jenkins, "Professor Ramsay acknowledges a recurrent fauna."

Certainly there is a recurrence of forms, *but only to a very limited extent.* The *fauna* of a province or of a formation means the collective species of the province or formation, and not a small percentage of them. My arguments in part are based on facts of that kind, *viz.* that in certain cases there is recurrence of species not in mass but in small numbers. In this case, out of about 700 Great Oolite species, only about eighteen or twenty per cent. are found in the inferior Oolites beneath, whereas, from want of showing how I considered the question as a whole, Mr. Jenkins' readers might imagine that the fauna of the Great Oolite, *is* the fauna of the Inferior Oolite *recurrent.* This is very far from being the case, and in my address I do not hint at anything that would lead to an inference so erroneous.

But supposing that there were a recurrence of Inferior Oolite complete species in the Great Oolite, or on a great scale, it may then occur to those who remember my addresses that they are expected to draw the inference, that the Inferior Oolite, Fuller's-earth, and Great Oolite are formations comparable in importance, physically and in their faunas, to the Silurian, Devonian, and Carboniferous formations, the faunas of which were supposed by Professor Huxley to have been possibly contemporaneous in different parts of the world. It might be allowable to compare the Oolitic Subdivisions named above, with any three minor subdivisions, for example, in Upper Silurian strata, but few Geologists will require to be reminded that such minor subdivisions are not comparable to the three great series, Silurian, Devonian, and Carboniferous, each of which contains several groups of formations, some of which groups are comparable to the whole Oolite series of Britain taken together.

IV. SYNTHETICAL CHEMISTRY.

1 *On the Synthesis of Organic Bodies.* Lecture at the Royal Institution of Great Britain, February 12, 1864. By J. A. Wanklyn.

2. *On Recent Chemical Researches in the Royal Institution.* Lecture at the same Institution, June 3, 1864. By Edward Frankland, F.R.S.

3. *On Researches in Organic Chemistry in the Royal Institution.* Lecture at the same Institution, June 9, 1865. Same Author.

4. *On Animal Chemistry.* A Course of Six Lectures at the College of Physicians. By William Odling, M.B., F.R.S. Especially Lecture 5, reported in the 'Clinical News' of September 8 and September 15, 1865.

There are hundreds of restless, prying men, who would to-day, as did the fabled Titan, steal down the fire from heaven and vivify a human form, or failing that, would be content to animate the merest speck of organized material.

This is the aim to which the efforts of mankind, at least of our most earnest investigators, are half-consciously tending at the present time; but whether or not it will ever come within the scope of man's ability so to mould the elements and imitate the work of nature, as to fit them for the reception of that mysterious force or combination of forces termed "life," it is impossible to say; at least, it is not the will of Him who is the author of all force, that man should, at this stage of his existence, stand forth as a creator even of the humblest living form. To go a step beyond this, and affirm that there is this or that in nature which he cannot do, or should not attempt; to dogmatize upon the things of which he ought to remain ignorant, or whose investigation should be avoided as an impious attempt to pry into and interfere with the Creator's works, is to exhibit the greatest want of faith, not alone in man's powers and destiny, but in the might and goodwill of his Maker: it means, in fact, to abdicate man's noblest powers, neglect his highest faculties, return to the darker stages of his existence,—for where there is no progress there must be retrogression,—and to make him the image of God in name alone and not in nature. The story of Prometheus is, in common with many others of a similar character, merely a childlike fancy of man in the earliest stage of his history, which is every day approaching realization in another form, just as the efforts of the old philosophers and alchemists were the result of dreams which have become in our day living realities. The creative powers of man have to be educated, just as all his other faculties; and this, the highest portion of his nature, has been more gradually yet more systematically developed than any other. The principle upon which his mind has been trained may be exhibited by a very simple illustration.

There are few of our readers who have not seen those interesting little puzzles shaped like a double cross. When the curiously-formed pieces of wood which constitute this cross are placed in our hands for the first time and we are invited to construct the object, we often spend hours in the vain attempt to do so; but let the pieces once be put together by hands that are in the secret, and the cross presented to us entire, and give us then the opportunity of carefully and observantly removing piece by piece until the whole is completely dissected, and we shall find but little difficulty in reconstructing what we had before laboured in vain to build up.

The simile, it must be admitted, is imperfect; but true it is that before we can synthetize we must understand *well* how to analyze; and it is not improbable that when all that the searching mind of man can accomplish in the unravelling of material complications has been effected, and when he sees with tolerable intelligence all the processes of nature in the dissolution of her living forms, and is able with the aided or unaided eye to follow her formative processes; when he has been able to accomplish all these things, then it is not improbable that he may become skilled enough to construct the organized tissue in which vital force (let physicists call it what they will) finds a medium of action, just as he is now capable of preparing those mechanical contrivances which are rendered self-moving by the obedient forces of the physical world. One important step has been already made in this direction, for if he cannot yet form that plastic material, that protoplasm, in which life is first seen to dawn, at least he has robbed nature of her exclusive privilege to create substances which it has hitherto needed vital influences to produce. If he cannot usurp her powers so far as to make organized tissues, at least he has succeeded in constructing synthetically some of the proximate principles of which they are constituted, and it is to the present state of his knowledge and attainments in this branch of chemical science that we now propose to direct attention.

When we compared the analytical and synthetical experience of our investigators with that of an ordinary person taking to pieces and reconstructing a well-known puzzle, we said that the simile is imperfect, for the power in man to build up organic substances is not the immediate sequel to his analytical experience. "The pulling to pieces of these substances," says Wanklyn, "is a matter of very little difficulty: more than fifty years ago chemists could do that—but how to put the pieces together again is a much more difficult task. Sugar consists of 72 parts by weight of carbon, 11 parts of hydrogen, and 88 parts of oxygen. We may bring together carbon, hydrogen, and oxygen in these proportions, and shake them up together, or heat them, or cool them, and yet we shall never get them to combine so as to form sugar. Alcohol consists of 24 parts of carbon, 6 parts of hydrogen, and 16 parts of oxygen, but no alcohol ever results from making such a mixture. Neither sugar nor alcohol can exist at the temperature to which it is requisite to raise our mixture of carbon, hydrogen, and oxygen, in order to get chemical action to set in. At ordinary temperatures the organic elements will not enter into combination, whilst at high temperatures they combine it is true, but yield comparatively very few compounds."

That the chemist has, however, been able, by a series of synthetical operations, to build up alcohol—a product which previously nature alone was able to furnish—will be seen presently; and not alone has he succeeded in fabricating this organic material, but many others, both in the plant and animal realm, the chief of these being oxalic acid, resembling that extracted from the common wood sorrel; acetic ether, the flavouring substance of certain wines (consequently the product of the grape-plant); amylic and butyric ether, the essences respectively of the pear and pineapple, in the vegetable kingdom; and in the animal kingdom, the well-known substance glycerine, the sweet principle of animal fats and oils; lactic acid, the acid of sour milk; formic acid, the product of vital action in ants; and leucine, a fine white powdery substance resulting from the treatment of certain organic tissues with dilute sulphuric acid. The last is ordinarily found in the spleen, pancreas, liver, bile, kidneys, and salivary glands. All these and many allied substances have of late been synthetically prepared from inorganic elements; but the first organic material thus artificially constructed was *Urea*, an excretory product of the mammalia, and this was effected by a German chemist (Wöhler), in the year 1828, in the following manner:—"Cyanide of potassium—a body which can exist at a red heat, and which can moreover be formed directly from its constituents, carbon, nitrogen, and potassium—was oxydized by means of peroxide of manganese at a low red heat, and so cyanate of potash was obtained. The cyanate of potash was next converted into cyanate of ammonia by double decomposition with sulphate of ammonia. Thus cyanate of ammonia was produced from its elements by a process which, although indirect, still did not involve the action of either a plant or an animal. Cyanate of ammonia becomes *urea* when its solution in water is simply evaporated to dryness."

This simple account, by Wanklyn, of the first step in synthetical chemistry, is followed by a recital of the discoveries of succeeding chemists. Three years afterwards, Pelouze, a French investigator, produced formic acid; and we shall now give his process, as described by Wanklyn, with a hearty tribute of praise to both these chemists for the services they have rendered to science.

If we pass nitrogen gas over a mixture of carbon and hydrate of potash heated to whiteness, cyanide of potassium is the result, and when that substance is boiled with a solution of hydrate of potash, formate of potash is produced. If we distil formate of potash with sulphuric acid, we then obtain *formic acid*, the acid of ants. This is the simple process by which Pelouze succeeded in building up formic acid, but the synthesis need not terminate here; if we slightly retrace our steps, we find that from one and the same substance, formate of potash, not only an animal acid is obtainable, but a vegetable acid may also be synthetized. For if formate of potash be heated with hydrate of potash the result is oxalate of potash, and from this we can obtain *Oxalic acid*, similar to that extracted from common sorrel, *Oxalis acetosella.*

Returning now to the history of this infant science, we find that in 1845, Kolbe, another German chemist, constructed *Acetic acid* from its elements, and the author of the discovery tells us that "if we could transform acetic acid into alcohol, and out of the latter could obtain sugar and starch, then we should be enabled to build up these common vegetable principles by the so-called artificial method from their most ultimate elements." A portion at least of the German savant's anticipations has been realized; for we *can* build up alcohol from its inorganic elements; indeed the discovery was in part made by our own chemists, Faraday and Hennell in 1820, before the synthesis of urea was effected by Wöhler, but their experiments were only recently confirmed and synthetically completed by the more extended researches of Berthelot. The following must serve as a description of the mode of producing alcohol by synthesis, and we trust that it will be found generally intelligible. The first step in the synthesis is the production of acetylene. When the carbon points used for the electric light are ignited by an electric current in an atmosphere of hydrogen, acetylene is produced. (The hydrogen may be obtained from water, and the carbon from marble, both inorganic sources.) With acetylene (a gas) we obtain acetylide of copper by passing the former through the subchloride of copper, and by bringing acetylide of copper into contact with nascent hydrogen we form *Olefiant gas.* This may be termed the second step in the synthesis, olefiant gas being itself an organic product. The third and final synthesis is that performed by Faraday and Hennell, and it consists, first, in the agitation of olefiant gas with sulphuric acid, the result of which is sulpho-vinic acid. This is then mixed with water and distilled, when alcohol comes over, mixed, however, with water; from which it is freed by placing it in contact with quick-lime for a day or two and then distilling it again at the temperature of boiling water. *Pure vinic alcohol* now passes over, all the water remaining behind in combination with the lime. Having thus obtained vinic alcohol from inorganic materials only, we can employ it to form, by synthesis, a vast number of other organic products. Thus by Mendius's reaction (so called after its discoverer), which consists in the addition of hydrogen to the compound of cyanogen with the basis of vinic alcohol, we obtain propylic, butylic, and amylic alcohol. If we select one of these, propylic alcohol, and oxydize it, we convert it into propionic acid; and when propionic acid is subjected to the consecutive action of chlorine and hydrate of potash, the product is the well-known substance *Lactic acid*, the acid of sour milk. Again, vinic alcohol submitted to oxydation produces *Acetic acid*, from which we may construct, by synthesis, the essences of certain fruits, often vended by druggists to persons who have not the remotest suspicion of the true character of their purchases. Having described the syntheses of vinic alcohol and acetic acid, it is only necessary to state that when these two are distilled together, they produce *Acetic ether*, the bouquet of certain wines; and again, if vinic alcohol be thrice treated according to Mendius's process we obtain amylic alcohol, and that substance distilled with acetic acid gives the "*Essence of pears.*" And further, if acetic ether (the bouquet of wines) be treated, first with sodium, and then with iodide of ethyl, it gives butyric ether, the "*Essence of pine-apples.*" How numerous are the dissimilar substances produced from almost the same simple elements; and how completely does the study of synthetical chemistry confirm all other evidences of the unity of the operations of nature!

Passing over the synthesis of *Glycerine* from propylic alcohol (one of the products of vinic alcohol already referred to), we may mention that the combination of glycerine with the so-called "fatty acids," acetic, propionic, butyric, &c., all of which are synthetized by the oxydation of propylic and other alcohols as already stated, that the combination, we say, of glycerine with the fatty acids yields *several oils and fats similar to animal and vegetable oils;* and now we will conclude this hasty glance at the synthesis of organic compounds by a brief reference to the substance *Leucine,* which has been found to characterize the tissues of the spleen, liver, kidneys, &c., of the mammalia.

We have already described the synthesis of vinic alcohol, and stated that Mendius converted that liquid into amylic alcohol, by treatment with cyanogen compounds and hydrogen. Now, if this amylic alcohol be carefully oxydized, it is converted into "Valerianic aldehyde." Another substance which may be prepared by synthetical chemistry from nitrogen, carbon, and potash, is cyanide of potassium; from this the well-known prussiate of potash is obtainable, and from prussiate of potash we easily procure the equally well-known substance, prussic acid.

When valerianic aldehyde, obtained synthetically, is treated with prussic acid (similarly prepared), the desired synthetized product, *Leucine,* is a result of the combination.

Thus, then, we see that organic substances yielded by plants, and others by animals, may be easily produced by synthetical chemistry from other compounds, of a kind more nearly approaching the products of inorganic nature, whilst these may themselves be synthetized from what we term the chemical elements.

But *cui bono?* will be the natural and inevitable question, to which it is always necessary now-a-days to give a prompt and satisfactory reply, otherwise synthetical chemistry will rank but one grade above alchemy and astrology. There need, however, be no difficulty in pointing out the immense benefits to mankind, which are sure to accrue from the practical study of this infant science. The advantages of being served with a compound of amylic alcohol and acetic acid when one goes into a shop to purchase essence of pears, or with a similarly prepared compound as a substitute for essence of pine-apples, may not be quite obvious to every one, and much as we may admire the ability of the chemist who manages to cheat our very senses, we cannot help avowing a preference for the genuine products of nature.

There are, however, organic substances used in the arts, for which the demand is becoming so large, that unless the manufacturing chemist steps in to the rescue, they will be placed beyond the reach of ordinary consumers; and as every day witnesses an increase in the number of such substances that may be synthetically prepared, it is impossible even to discuss the probable boundary within which the unpretending researches of the laboratory are to be confined. At present the application of the science in the direction here pointed out appears unlimited. But there is a question at issue of far greater moment than the tickling of the human palate, or even the supplying of some of man's more indispensable domestic requirements; the health, the very life of man, is affected by these new discoveries in science.

The practice of hygiene may in one sense be compared to that of agriculture. The old fashioned farmer used formerly to apply special composts and manures to the soil for promoting the growth of particular plants, though there was a period when he applied the same manure in every case. Even after his experience had taught him that the growth of particular plants is fostered by special manures, he was still ignorant of the why and the wherefore. All he knew was that it *was* so. Presently the researches of the agricultural chemist revealed the constituents of the various plants, and enabled the farmer intelligently to apply the respective materials of which the soil had been exhausted. The analyst performed the diagnosis; the farmer, under his advice, effected the cure, and precisely so it is in the practice of medicine.

Inquire of a medical man, even to-day, what means he is employing to relieve some particular disease or to sustain a sinking frame, and too often the reply is, avowedly or by inference, that he is essaying first one and then another medicinal agent to effect a desired end; groping about, as it were, by a dim and uncertain light. Now the analyst and synthetist come to his aid, and together they stand in the same relation to him as the agricultural chemist to the practical farmer. Between them they must ascertain the organic constituents of which the system stands in need, and if nature cannot be pursuaded to supply the deficit, it will be the joint duty of the synthetical chemist and physician to do her work.

It is indeed difficult in this early stage of the science to define precisely under what circumstances synthetical chemistry will step in to the aid of the baffled medical practitioner, but that it has already done so in some instances, no one will venture to deny, nor will any one, on the other hand, pretend here, as in the case of its application to the arts, to mark the boundary within which the operations of the laboratory will in future be confined.

So much for the consideration of two of the leading utilitarian aspects of synthetical chemistry, but, as we hinted at the commencement of this essay, the highest aim of this as of every other effort of the human intellect, is to increase his knowledge of the laws of nature, to extend his power of controlling and utilizing her operations, and to obtain a better insight, so far as his senses will allow him, into the works of the Creator. Perhaps, with reverence be it spoken, to prepare himself, by the fabrication of organic and it may be even of organized matter, to become one day, here or hereafter, a creator himself under the divine government.

The increase of social comforts and enjoyments, then, his bodily health, and his mental development are the legitimate motives that should actuate man in prosecuting the study of synthetical chemistry.

Synopsis of Chemical Reactions referred to in the foregoing Article.

1. Synthesis of acetylene ($C_2 H_2$) from hydrogen and carbon in the electric arc (Berthelot).

2. By passing acetylene gas through subchloride of copper, acetylide of copper is produced.

3. Acetylide of copper in contact with nascent hydrogen, gives olefiant gas ($C_2 H_4$).

4. Agitated with sulphuric acid, olefiant gas produces sulphovinic acid ($SO_4 C_2 H_6$), from which common or vinic alcohol ($C_2 H_6 O$) is readily obtained.

5. From vinic alcohol the following alcohols can be produced by Mendius's reaction :

Propylic Alcohol . . .	$C_3 H_8 O$
Butylic Alcohol . . .	$C_4 H_{10} O$
Amylic Alcohol . . .	$C_5 H_{12} O$

6. By the oxydation of these alcohols, they yield respectively the following organic acids:

Vinic Alcohol	yields	Acetic Acid.
Propylic Alcohol	,,	Propionic Acid.
Butylic Alcohol	,,	Butyric Acid.
Amylic Alcohol	,,	Valerianic Acid.

7. From propionic acid, the acid of sour milk—lactic acid ($C_3 H_6 O_3$) is obtained by the consecutive action of chlorine and hydrate of potash.

8. From the alcohols, the zinc compounds of the alcohol radicals are obtained; *viz.* from

Methylic Alcohol . .	Zinc Methyl.
Vinic Alcohol . . .	Zinc Ethyl.
Amylic Alcohol . .	Zinc Amyl.

9. By the action of the zinc compounds of the alcohol radicals upon oxalic ether, the following acids of the Lactic family are produced, of increasing complexity :

Dimethoxalic Acid	$C_4 H_8 O_3$
Ethomethoxalic Acid	$C_5 H_{10} O_3$
Diethoxalic Acid	$C_6 H_{12} O_3$
Amylohydroxalic Acid	$C_7 H_{14} O_3$
Ethyl-Amylhydroxalic Acid . . .	$C_9 H_{18} O_3$
Diamyloxalic Acid	$C_{12} H_{24} O_3$

10. When nitrogen gas is passed over a mixture of carbon and hydrate of potash heated to whiteness, cyanide of potassium (KC N) is produced.

11. When cyanide of potassium is boiled with solution of hydrate of potash, formate of potash ($CHKO_2$) is produced. From this, formic acid ($CH_2 O_2$), the acid of ants is obtained by distillation with sulphuric acid.

12. When formate of potash is heated with hydrate of potash, it is converted into oxalate of potash ($C_2 K_2 O_4$), whence oxalic acid ($C_2 H_2 O_4$), same as from oxalis acetosella.

13. Oxalic acid heated with alcohol gives oxalic ether ($C_6 H_{10} O_4$) used in No. 9.

14. By the action of anhydrous phosphoric acid upon the acids No. 9, the latter are converted into acids of the Acrylic series, thus:

Dimethoxalic Acid gives Methacrylic Acid . .	$C_4 H_6 O_2$
Ethomethoxalic Acid gives Methylcrotonic Acid	$C_5 H_8 O_2$
Diethoxalic Acid gives Ethylcrotonic Acid . .	$C_6 H_{10} O_2$

15. Distilled with alcohol, acetic acid gives acetic ether ($C_4 H_8 O_2$), and with amylic alcohol, amylic acetate ($C_7 H_{14} O_2$). The first constitutes the bouquet of several wines, the second is the essence of pears.

16. Acetic ether, treated first with sodium and then with iodide of ethyl, gives butyric ether ($C_6 H_{12} O_2$), the essence of pineapples. For other synthetized products similarly obtained and in prospect, *see* Lecture, June 9, 1865, p. 2, *viz.*:

Propionic Ether .	$C_5 H_{12} O_2$	Œnanthylic Ether .	$C_9 H_{18} O_2$
Diethacetic Ether .	$C_8 H_{16} O_2$	Margaric Ether . .	$C_{17} H_{34} O_2$

17. From propylic alcohol, glycerine ($C_3 H_8 O_3$) the sweet principle of animal fats can be obtained.

18. By the combination of glycerine with the fatty acids, synthetized according to No. 6, oils and fats similar to animal and vegetable oils and fats are produced.

19. By careful oxydation, amylic alcohol is converted into valerianic aldehyde; and this, treated with prussic acid (got from cyanide of potassium, *see* No. 10), is transformed into leucine ($C_6 H_{13} NO_2$), found in the spleen, pancreas, liver, bile, and kidneys, and in the salivary glands.

V. ANTHROPOLOGY.

1. *Lectures on Man: his Place in Creation and in the History of the Earth.* By Dr. Carl Vogt. Edited by James Hunt, Ph.D. London, 1864.
2. *The Plurality of the Human Race.* By Georges Pouchet, M.D. Translated and edited by H. J. C. Beavan. London, 1864.
3. *Memoirs Read before the Anthropological Society of London.* Vol. I. 1863–4. London, 1865.
4. *The Anthropological Treatises of Johann Friedrich Blumenbach.* Translated and edited by Thomas Bendyshe, M.A. London, 1865.

The works, the titles of which we have placed at the head of this article, have been issued by the Council of the Anthropological Society of London, to their fellow members during the past twelve months, and may be accepted as affording a tolerably faithful representation, not only of what the Society has accomplished during that period, but what are the tendencies and objects of its principal members.

We have heard or read somewhere, that if a number of young men, with some small share of ability, were to unite together and form a society, one of the leading rules of which should be to lose no opportunity of sounding each other's praises, the world might in process of time be almost brought to believe that a new and dazzling coruscation of talent had blazed forth, and that a fresh and startling revelation would shortly be announced. This seems to be the principle on which the leading members of the Anthropological Society of London have acted, such the process by the agency of which they seek to reach the Temple of Fame. Accordingly, we find the President, Dr. James Hunt, quoting, and of course with much approbation, the sayings and doings of the Assistant-secretary, Mr. C. Carter Blake. Member of Council, Mr. Beavan, is equally complimentary; and so the pleasant and highly-seasoned ball of flattery is tossed to and fro between President and Vice-president, Secretary, Treasurer, and Member of Council, though, we must confess, we are unable to see what these gentlemen have either said or done to merit so much laudation as they lavish on each other.

Vogt's work on Man consists of a series of lectures delivered at the request of the Useful Knowledge Society, of the Canton of Neufchâtel. It is written in a popular form, and discusses the interesting problems of man's antiquity on earth and his relations to the lower animals, which have been rendered so familiar to the English public by the recent writings of Darwin, Lyell, and Huxley, and by the many controversies and discussions to which they have given origin. Hence those who have kept themselves at all on a level with these subjects will not find much that is new in the work before us, and we are somewhat at a loss to understand why these lectures, however well they may be adapted to place a German-speaking audience *au courant* with these problems, should have been selected by the Council of the Anthropological Society for translation and publication to their members; for we should have supposed that the members of a society which professes "to investigate the laws of man's origin and progress," would not have required to go to a foreign source for information on these topics, but would have made themselves acquainted with the writings of the most important at least of those men of science in this country who have communicated their speculations to the world, and with whom indeed it may be said that most of the recent theories and surmises on these subjects have originated.

We should not, however, have pressed this objection to the translation of Vogt's Lectures if, after perusal of the book, we had felt that the argument had been fairly stated, and that a spirit of candour and a desire to seek for the truth, even though it might at first sight seem to be opposed to the predilections of the author, had pervaded its pages.

When the man of science enters on the physical investigation of a subject, which goes so far back in the history of the world as the first appearance of man upon earth, every step should be taken with the utmost caution, every seeming link in the chain of evidence should be weighed and tested with the greatest care; for though man's advent may not date from the dawn of time, and though he may not be able to claim an antiquity comparable to that of the *Eozoon canadense*, yet the tendency of all recent inquiry is to throw him much farther back than was at one time supposed, and to make him a contemporary of animals long since extinct, so that man, as he first appears in written history, is, compared with man primeval, but as a creature of yesterday.

Vogt is a most strenuous advocate for this extended antiquity of the human race, and he has given a very readable account of the various localities in which human bones, or objects apparently the work of human hands, have been met with under circumstances which manifestly point to a high antiquity. But in his desire to prove his argument, he has not exercised sufficient discrimination in the selection of his cases, and has accepted as evidence certain supposed proofs which have not stood the test of a rigid investigation. We may refer more especially, in support of our statement, to his account of the much talked of Moulin-Quignon jawbone, the authenticity of which he accepts without hesitation, although some of our most distinguished English palæontologists are unable to accept it as genuine. Again, he pronounces the Engis Cave skull, respecting the antiquity of which there seems to be no question, to be "one of the most ill-favoured, beast-like, and simious skulls we know of," though we must confess we see nothing in its form to justify such an opinion; and we fully coincide with the statement made by Professor Huxley, that there are no marks of degradation about it. But Vogt is a firm believer in the descent of man from the simious group standing next him, and therefore it suits his purpose to make out that the crania of the primeval races possessed an ape-like form. In his desire to believe anything which may seem to lend support to his argument, Vogt displays a readiness which stands out in marked contrast to the scepticism he displays upon other subjects which most men, at least in this country, are accustomed to hold in reverence, and to treat with consideration and respect. There are so many sins against good taste, so much that is offensive in the lectures, that some slight qualms of conscience as to their applicability to the tastes of the British public seem even to have affected the not very fastidious editor, Dr. James Hunt, for he confesses in his preface, "that at first I omitted a few passages which I did not think in good taste, but on proceeding with my labour I found that to cancel all the passages which might offend would be entirely to alter the character of the work." On re-consideration, therefore, he has effected a compromise, and, like the ingenious editor of a copy of the epigrams of Martial we once met with in our school-days, he has struck out of the text some of the more ribald passages and has printed them as an appendix, where, in a concentrated, and, let us hope, nauseating form the reader may have the opportunity of perusing as choice a collection of scientific Billingsgate as is to be found in the English language.

M. Pouchet's work, "On the Plurality of Races," is on a subject which has of late years, more especially in France and America, attracted considerable attention. In the former country it has been discussed with much ability by various distinguished men of science, and all that can be stated on the subject in the present condition of our knowledge seems to have been said by the advocates of one or the other side of the question. M. Pouchet, as the title of his essay would indicate, is a strenuous supporter of the descent of man from more than one primitive stock. Moreover he scouts the idea of a distinct human kingdom, and considers that the physical and psychological differences between man and the apes are not of kind, but merely of degree. He considers man to be comparable in all points with animals, and that a common origin ought to be sought for him and them. He laughs at the notion of a creation, and finds this common origin "in a mass of amorphous matter, which at a later period will form itself, or in the midst of which will be *spontaneously* developed, an anatomical element, that is to say, an organized body." Though how the "mass of amorphous matter" was itself formed, or what were the forces or agencies which induced the development of the "anatomical element" in it he does not condescend to tell us. Of such and similar loose assertions the essay is in a great measure composed, and the number of facts which the author advances in support of his statements, is so small that one is tempted to exclaim with Prince Hal, "O monstrous! but one half-pennyworth of bread to this intolerable deal of sack!"

The volume of memoirs issued by the Anthropological Society consists of the most important papers read before it during the Session 1863–64. The first on the list is by the President, "On the Negro's Place in Nature;" but as it has already been noticed in the pages of this Journal, in connection with the meeting of the British Association in Newcastle, we need not allude to it further. Then follows a short but interesting paper by Dr. Peacock, in which are recorded the results of some observations on the weight of the recent brain in four negroes. His observations "tend generally to support the conclusions of Sir William Hamilton and Professor Tiedemann, that there is no very marked difference between the ordinary size of the brain in the African and the European; but they certainly indicate that the brain is usually somewhat smaller in the former race than in the latter." Mr. Bollaert contributes three elaborate papers "On the Astronomy of the Red Man," "On the Palæography of America," and "On the Past and Present Populations of the New World." As showing the great destruction of the aboriginal population, he states that the number of natives at present inhabiting the great western continent is probably not more than between ten and eleven millions, whilst at the time of the discovery of America in 1492, the population was over 100 millions. Messrs. Thurnam, Davis, and C. C. Blake furnish each a memoir on craniological subjects. Dr. Thurnam's is on ancient British and Gaulish skulls, a subject on which no man is more fitted to speak with authority. To attempt anything like an analysis of this very exhaustive paper in the space at our disposal is impossible. We may, however, cite the general conclusion he has arrived at, that there is proof of a succession of two primitive races—a long-headed and a short—in Britain in pre-Roman times, the dolicho-cephalous being the earlier of the two; but, as to France, he agrees with Carl Vogt in saying, "the farther we go back, the greater is the contrast between individual types, the more opposed are the characters,—the most decided long-heads immediately by the side of the most decided short-heads."

In a short memoir, entitled "Notes on certain Matters connected with the Dahoman," Captain Richard F. Burton congratulates his fellow-members that a society has at length arisen, in which a liberty of speech and a freedom of thought hitherto unknown in Great Britain is enjoyed, and then proceeds, evidently *con amore*, to give an account to his brethren of the filthy customs of the degraded negroes of the kingdom of Dahome. Mr. W. T. Pritchard follows in the same track, with a description of some practices, equally foul, pursued by the Samoan islanders; both these writers apparently having the idea that the leading function of this science of Anthropology, which they profess to promote, is to exhibit man in his most brutal and degraded aspects, and to avail themselves to the full of that "liberty" of speech which they believe to be the marked feature of the Society. And as an illustration of the reckless way in which another writer makes a statement, without advancing a shadow of proof in its support, we may refer to a paper "On the Phallic Worship of India," by Mr. Edward Sellon, in which it is stated that "there would also now appear good ground for believing that the ark of the covenant, held so sacred by the Jews, contained nothing more nor less than a Phallus, the ark being the type of the Argha or Yoni."

Of the last volume we need say no more than that it is principally made up of a translation of the treatise of the distinguished anatomist and physiologist, Blumenbach, "On the Natural Variety of Mankind," and of a translation of an inaugural dissertation on the same subject, written in 1775, by a certain Dr. John Hunter, an Edinburgh graduate, who is not, our readers must bear in mind, *the* John Hunter, who founded the great museum in Lincoln's Inn Fields.

VI. THE PROGRESS OF ZOOLOGY.

The Record of Zoological Literature, 1864, *Vol. I.* Edited by Albert C. L. G. Günther, M.A., M.D., F.Z.S., &c. London: Van Voorst, 1865.

In the present age of thought and busy activity, when every department of science has so many diligent workers, the accumulation of facts is so vast and so rapid, that their arrangement into something like systematic order is a real boon to the scientific investigator. The Year Book is now a recognized part of our literature, and the compilation of such laborious productions is of greater or lesser service according to the amount of intelligence and method brought to bear upon the collection and arrangement of the material. The greater the simplicity that can be introduced into such a digest the more valuable it becomes for reference, but it requires powers of mind of a superior order to condense and arrange upon a simple and intelligent plan a vast and heterogeneous mass of materials, such as a crowd of ardent workers have been busy upon during twelve months over the civilized world. Such a task has Dr. Günther set to himself in the preparation of a volume which shall record the labours of zoologists during the year 1864, and we must confess that he has produced a work which cannot fail to prove of the utmost service to all zoological investigators. The quantity of printed scientific matter here condensed amounts in the aggregate to upwards of 25,000 pages, a sum which it would be obviously impossible, independently of other reasons, for one man duly to chronicle with accuracy; and the work before us has therefore been wisely distributed among a number of gentlemen well known in the departments they respectively represent. Throughout the whole, however, the editor has aimed at unity of plan, and has well succeeded on the whole in securing it, although it is natural that a certain complexion is given to each record "according to the individuality of the recorders." To secure this uniformity, however, it was recommended that each record should commence with a general list of the various publications, while the second part of the record should be of a more special character, containing abstracts of important papers, more particularly of those which are difficult of access. Abbreviated diagnoses of new species were to be given with exact references and fuller descriptions when occurring in little-known journals. All anatomical papers were to be mentioned, but only those directly bearing on classification, specific definition, or the life history of an animal were to be more specially treated. Nor were sound popular works to be omitted in the category, a determination which we think was arrived at with wisdom and liberality.

Dr. Günther himself undertakes the Mammalia, among which Dr. Gray and Mr. Flower appear to have been the most diligent workers in this country, and Peters and Van der Hoven among continental zoologists. Considerable prominence is given to Dana's method of classification on the principle of cephalization of the body, that is, the subordination of its members and structures to head-uses; and the order *Cetacea* appears to have benefited most by researches during the past year. We may regard this first instalment by the editor as a model record, in which it is a matter of extreme facility to discover any point which the investigator is desirous of arriving at, or any paper which he may wish to consult. Having set so excellent an example, we shall hope to see it generally followed in future volumes of the 'Record,' as far as the complexity and vastness of the material of certain departments will allow.

Mr. Alfred Newton, to whom was confided the class Aves, has, we think unfortunately, departed somewhat from this simplicity, on which the main value of the 'Record' depends. In his general list at the commencement, instead of following a generally understood order of arrangement, he at once splits up his matter into regions, Palæarctic, Œthiopian, Indian, Australian, Nearctic, and Neotropical, followed by other subdivisions of descriptive Anatomy, Pterylography, a newly invented term, *Neossology*, and Oology. If the work is intended solely for professed ornithologists, perhaps this division may be considered to have its advantages; but to persons not familiar with Dr. Sclater's geographical distribution of birds, these divisions are somewhat puzzling, and necessitate a hunt through the whole, the divisions being at least useless. In the special part of this subject the same divisions are used, which would save further trouble if the paper is found in the first list, but which is otherwise open to the same objections. We do not doubt that Mr. Newton has used his best judgment in this mode of treating his department, but we would suggest that it is capable of improvement. Among birds, our ornithologists, Gould, Sclater, Wallace, Salvin, Swinhoe, and others, have left the impress of their labours, and they are worthily supported by continental brethren, such as Hartlaub, Pelzeln, Rosenberg, and others. As we might suppose, from their numbers, the Passeres have received the greatest amount of attention and the largest accessions, though every other order has made steady and interesting advances. One of the most interesting ornithological events of the year was the exhibition, by Mr. Thomas Allis, of York, of the very recent remains of a Dinornis robustus, at a meeting of the Linnean Society. This bird had been found in a sand hill, about 100 miles from Dunedin, in the middle island of New Zealand, and in such preservation that a considerable portion of the outer skin, studded with the quill part of the feathers, remained.

No one could be more fitted to record the progress of Herpetology than Dr. Günther himself, this being his own special subject; and the same remarks apply to this portion of the work which were made with reference to the record of Mammalia. The chief work of the year in this department is undoubtedly Dr. Günther's elaborate memoir on the "Reptiles of British India," published with twenty-six most beautiful and life-like plates, by the Ray Society. In this work he describes no less than 526 species, many of them new. Besides this great work, several minor contributions are from Dr. Günther's pen. Dr. Gray has also been very prolific of papers in the systematic department of this subject. It appears that the number of reptiles known has much increased of late years, and Van der Hoven's estimate of 1,500 species is regarded as much too low. The Chelonia have received much elucidation from Dr. Gray, more particularly the Asiatic and African species of freshwater turtles. Mr. Cope, of Boston, and Dr. Günther have been the chief investigators of the Saurian reptiles. Peters, Dumeril, and Günther, of the Ophidians. The question of the position of the Amphibia with regard to reptiles has been again raised by Dana, and the view seems to obtain favour from Dr. Günther, that Amphibians form a distinct group in the class of reptiles—a view which is strengthened by the analogy drawn from other classes of Vertebrata; the Mammals have their *inferior* sub-division, the *Oötocoids*, or semi-ovoviviporous species (Marsupialia and Monotremata); the birds have *their* inferior sub-division, the *Erpetoids* (Archæopteryx), and between ordinary Reptiles and Fishes there are Amphibians, forming a similar hypo-typic subdivision of reptiles.

The editor of the 'Record' has taken his share of the work, and appears also as the compiler of the copious article on Fishes, a subject in which he is also a great authority. His catalogue of the fishes of the British Museum is an important monument of his labours in this division of Zoology. In this catalogue, which forms a complete handbook to Ichthyology, all the species known are described and systematically arranged. Up to the present time, five volumes of this catalogue have been published, the first three containing the 3,481 species of Acanthopterygii at present known, the fourth and fifth describing nearly 2,000 other species; but the work is still incomplete, upwards of 8,000 species being known, nearly equally divided between freshwater and salt. But in the European fauna, the ratio between freshwater and marine species is as one to three. Another important work is a collected account of the Ichthyology of the East Indian Archipelago, by M. P. Bleeker, published by the Dutch government. Four volumes in folio have appeared. Dr. Bleeker has spent twenty years in this study, and the present work is chiefly a republication of descriptions, accompanied by very accurate plates from drawings made in India. The fishes of Finland, too, have been described by Herr Malmgren, who propounds theories of the specific identity of the different European Salmonoids, which are strongly combated by the editor. Among the contributors of papers to the literature of Ichthyology, Dr. Günther, Mr. Gill, and Dr. Bleeker figure conspicuously; and Mr. Gill's theory of the typical Leptocephali being the larval form of young congers, coupled with Agassiz' views of the metamorphoses of fishes, is not the least noticeable part of their history to which attention has recently been called. Mr. Gill promises a more extended memoir upon this subject, and the avowed purpose of Agassiz' journey to South America is to study the metamorphoses of the fishes of the Amazon, so that we may hope for more light upon this very remarkable subject.

The article upon "Mollusca" is supplied by Dr. Eduard von Martens, himself a copious contributor to the literature of the subject. By far the greater portion of the publications on this class of animals is devoted, observes Dr. Von Martens, to descriptions of species belonging to types more or less previously known, and more especially of their shells, as is usually the case in this department of Zoology. The most important work at present in progress is Lovell

Reeves' magnificent "Conchologia Iconica." The number of species of Mollusca recently described as new, but without indication of their habitat, is fortunately not large, so that our knowledge of the geographical distribution of the Mollusca is also advanced by most of these papers, especially by those in which an enumeration of all the species found in the same district is added. The faunas of Eastern Asia and Australia have been more particularly enriched during the past year. The systematic arrangement has not been essentially changed, but a considerable number of new genera (perhaps rather too many) have been introduced into science. The Cephalopoda and Pteropoda appear to have been entirely neglected. The Nudibranchiata have been well illustrated with new South American species, by Mr. Angas, and by the publication, by Messrs. Alder and Hancock, of the beautiful series collected by Mr. Walter Elliot, at Waltar, in the Madras Presidency; but the great mass of observations collected upon the Mollusca refer to the Gasteropoda.

The Tunicata and Polyzoa (Molluscoida) chronicled by Mr. J. Reay Greene, are chiefly illustrated by Dr. J. D. Macdonald and Mr. Alder, respectively. Dr. MacDonald is of opinion that the Molluscoida and Cœlenterata together form an unbroken series of animals to be placed between the Mollusca proper on the one hand, and the Protozoa on the other. The members of the group thus constituted, though developed from true ova, are prone to form compound organisms by continuous gemmation. In all, the movement of the circulatory fluid is effected either by ciliary action, or by a propulsive organ unfurnished with valves. Thus, starting from the Ctenophora (Beroë) as a central group, we proceed in two directions towards the Molluscoid or higher, and the Cœlenterata or lower, divisions of the series.

Mr. Spence Bate's Chronicle of the Literature of the Crustacea for 1864, enters, perhaps, more fully than any other into debated questions and interesting points of detail, and his summary of Fritz Müller's memoir on behalf of the Darwinian theory on carcinological grounds, is valuable. The principle of Müller is that the surest way to prove the correctness of Darwin's views would be to apply them to a particular group of animals, going as much as possible into detail. Such an attempt to set up one common pedigree, whether for the families of a class, or the genera of a large family, or for the species of a rich genus, and to trace out as clearly and comprehensively as possible their common origin, might either lead to contradictions in the theory which would demonstrate its error, or the theory might throw light upon the succession in which the various circles separated from the common type and from each other; or thirdly, although the experiment might fail, yet should it succeed, it would, from its independent and perfect character, be considered evidence of real value;

and to this conclusion he is led by his researches. The very curious investigations made by Dr. Hansen upon the auditory organs of the Decapod Crustacea, and the remarkable researches of Fritz Müller on Penæus, as well as some other of the interesting questions of crustacean metamorphoses, are very fully noticed by Mr. Spence Bate, and these abstracts of valuable papers very much add to the interest and utility of the record. Each division of the Crustacea appears to have been well represented by various investigators, the Cirripeds having perhaps received least attention.

Nearly one half of the Zoological Record is taken up by the laborious and careful account of the literature of the Arachnida, Myriapoda, and Insecta, prepared by Mr. W. S. Dallas, of York. We must congratulate the editor upon having secured the services of so careful and painstaking a coadjutor, for the labour exhibited in this part of the volume is truly immense, and the result of great service to the crowd of entomologists who appear to number in proportion to the host of insects upon which their attention is concentrated. This is a fortunate circumstance or otherwise the arrears of insect literature would be enormous, and Entomology would fail to keep pace with the other branches of Zoology. It is in this department, however, that the descriptions of species, and the minute attention to specific differences, preponderate over the more comprehensive views of material relations, and those zootomic studies which characterize the researches of most other zoological investigators ; not, however, that philosophic entomologists are wanting—we should be sorry to imply that—but the tendency of the exclusive study of entomology appears to be the development of that microscopic eye which can readily detect minute shades of colour and variations of form, and which is useful in its way, although not of the highest character as an intellectual effort. We cannot therefore, owing to the great mass of material, here attempt to give anything like a general view of the researches made in Entomology proper, but will content ourselves with saying that a vast number of new species have been added to the lists, a great many new genera formed, and Entomology in general as a science considerably advanced. The various departments of Coleoptera, Hymenoptera, Lepidoptera, Diptera, Neuroptera, Orthoptera, and Rhyncota have each received a fair share of attention. Among the students of Arachnida our own countryman, Blackwall, occupies a prominent place, whose "History of the Spiders of Great Britain and Ireland" is the most noticeable contribution of the time.

The remainder of the articles in this 'Record' are comparatively brief, although by no means on that account unimportant. Mr. J. Reay Greene supplies the Rotifera and Annelids. Two papers only occur in the former, of which summaries are given; but the Annelids are, as might have been expected, better represented.

Besides an important work on the Setigerous Annelids, by Ernst Ehlers, which is in course of publication at Leipzig, several interesting and important papers by Baird, Kölliker, Van Beneden, and others, indicate that this somewhat neglected department is making progress. Kölliker finds numerous sensory organs upon the integument of certain Polychæta, in the form of variously shaped hairs and papillæ, to which nerves are supplied which subserve to tactile functions; and Semper takes note of similar tactile bodies in the form of horny-toothed rings connected with vesicular arrangements surrounding nerves in Sipunculi.

Dr. Cobbold chronicles the Helminths, a subject which, from its human interest, obtains a considerable share of notice. Dr. Cobbold's own excellent treatise is the first original work on Helminths which has issued from the English press, and contains a valuable bibliography of the subject. The Germans are the chief students of Entozoa, and a great work by Rudolf Leuckart on human parasites is now in course of publication. Besides these, Friedrich Mosler, Virchow, Althaus, Diesing, and others have contributed important additions to this department of Zoology.

Lastly, the Echinodermata again call forth Mr. Reay Greene. Under this head the researches of A. Agassiz on the Embryology of Echinoderms, and of Sars upon similar subjects, which being made entirely independently, yet well confirm one another, are worthy of especial notice. With regard to the grade of development, it is remarked that on Embryological grounds the Asterids with suckers rank above those with tentaculiform feet; those with four rows of suckers, above those with only two; those with complicated spines and plates, above those with smooth arms; and lastly, those with elongated arms, above starfishes whose outline is pentagonal.

Here, we regret to say, we must close this chronicle. We heartily sympathize with Dr. Günther in his disappointment, that the gentleman to whom were entrusted the Cœlenterata and Protozoa failed to keep his engagement; and that since this did not become apparent until after two months' waiting, it was then too late to find a substitute. The consequence, of course, is that this first volume of the 'Zoological Record' is incomplete. As far as possible the deficiency will be made up in the following year, but everyone must regret the fact. In conclusion, we are glad to bear our testimony to the extreme value of the volume before us, and we trust that the substantial encouragement given to it by the sale of this edition, will induce the editor to continue his useful labours, since any Zoologist who has come into possession of such a treasure would sadly miss it if it were not forthcoming in future.

VII. THE ORIGIN AND ANTIQUITY OF MAN.

On the Occurrence of Stone Implements in Lateritic Formations in various Parts of the Madras and North Arcot Districts. By R. Bruce Foote, of the Geological Survey of India. With an Appendix by William King, jun., B.A., of the Geological Survey of India. Madras. 8vo. 1865.

On the Asserted Occurrence of Human Bones in the Ancient Fluviatile Deposits of the Nile and Ganges; with Comparative Remarks on the Alluvial Formation of the two Valleys. By the late Hugh Falconer, M.D., F.R.S., For. Sec. G.S. Quart. Journ. Geol. Soc., vol. xxi., pp. 372–389.

Researches into the Early History of Mankind, and the Development of Civilization. By Edward Burnet Tylor. London: Murray. 1865.

Prehistoric Times; as Illustrated by Ancient Remains and the Manners and Customs of Modern Savages. By John Lubbock, F.R.S., V.P.L.S., F.G.S. . London: Williams and Norgate. 8vo. 1865.

The Origin and Antiquity of Man are subjects which have of late years acquired the highest interest and received the greatest attention, through the discovery, in stratified and undisturbed deposits in France and England, of works of art associated with the remains of extinct animals. These discoveries are so well known, that it is unnecessary for us to review the general question; we shall therefore merely notice a few of the recent publications of more than ordinary importance; and it accidentally happens that their scope and character enable us to discuss more particularly a limited and most interesting portion of the subject.

Since the acceptance of M. Boucher de Perthes' views of the nature and age of the flint implements of the valley of the Somme, the search for similar instruments elsewhere has been prosecuted with remarkable enthusiasm. From the title of Mr. Foote's memoir, it will be seen that even the Asiatic continent has now yielded evidence that man existed in tropical regions at a period anterior to the formation of the existing physical features of the country. We know, within comparatively narrow limits, the age of the valley-gravels of France and England, and assuming that they indicate approximately the period of man's advent in Europe, the question will naturally arise,—At what period of the world's history did man first appear in India?

The extension into Asia of the known range of ancient flint implements, or corresponding weapons, was long preceded by the promulgation of the late Dr. Falconer's hypothesis that the gigantic fossil Tortoise of the Sewalik Hills may have lived contemporaneously with man in India. This speculation (which its author has re-enunciated in the paper whose title we have given above), the consequences which result from its acceptance, and from the acceptance of the arguments used in supporting it, are what we shall chiefly consider in this notice, the more especially as Mr. Foote's pamphlet has a direct bearing on its probability, as well as being an important addition to our knowledge. It must be stated, however, that this hypothesis is avowedly nothing more than suggestive; and whatever its ultimate fate may be, its lamented author's memory will not lose by its promulgation any of the lustre with which his name is now invested, for the idea of a Miocene man has already been adopted by some of the highest authorities on the subject, though rejected by others.

In endeavouring to estimate the bearing of known facts on its probability, we have arrived at somewhat adverse conclusions, but they are given with the highest admiration of the ingenuity displayed in the conception and elaboration of the idea, and of the genius of the naturalist who advanced it.

Of Mr. Tylor's book we ought to say at the outset that it is a work of very great interest and ability; the facts contained in it are brought together from various sources, but a large number of the inferences drawn are original. In the department of Comparative Mythology, the author's division of legends, traditions, and the like into Historical Traditions, Myths of Observation, and Pure Myths would be useful, if the separation were more easy to make in practice. His chapter on the Geographical Distribution of Myths is also very instructive, although he often seems to draw a conclusion from insufficient evidence. We cannot help remarking, also, that although a ludicrously inconsequential argument may, when skilfully employed as an illustration, create an impression that another train of reasoning is fallacious, it by no means proves that such is the case.

Mr. Lubbock's book consists of a series of essays and lectures which have been published to a greater or less extent before; it treats chiefly of a more ancient period in the history of man than Mr. Tylor's, to which it forms a useful introduction, though scarcely of equal scope and originality.

The gigantic extinct Tortoise of the Sewalik Hills (*Colossochelys Atlas*) was discovered in the Miocene deposits of those mountains by the late Dr. Falconer and Captain (now Sir Proby) Cautley; it was described by them in 1836, but the detailed account of it was not published until 1844; it is believed to have possessed a shell 12 feet long, 8 feet in transverse diameter, and 6 feet high! In the Proceedings of the Zoological Society for 1844, Dr. Falconer speculated on the date of the extinction of this gigantic animal, and he reproduces in his paper just published the more cogent of the arguments he then used, with others which serve further to elucidate his meaning. Dr. Falconer's strong point is the existence of traditions of a gigantic tortoise, comparable in size with the elephant, connected with the cosmogonic speculations of nearly all eastern nations, and he asks, "Was this tortoise a mere creature of the imagination, or was the idea of it drawn from a reality like the *Colossochelys?*" If the latter part of the question be answered in the affirmative, then the inference seems plausible that the *Colossochelys* may have co-existed with man.

Mr. E. B. Tylor considers* the whole story of the World-tortoise to be a "Myth of Observation;" he also shows that it exists in the New World, and states† that this occurrence of the tradition in the two hemispheres "leaves not the least opening for the supposition of its having been carried by modern Europeans from the Old to the New World." In his opinion also‡ the various stories of the World-tortoise may be resolved into the conception of the world as "a flat plain over which the sky is placed as a dome, as the arched upper shell of the tortoise stands upon the flat plate below."

On the other hand, Dr. Falconer brings forward a considerable amount of cumulative evidence in support of his hypothesis. He shows that in the Pythagorean cosmogony and in the Hindoo mythology reference is frequently made to different animals of extravagant magnitude, but whose conception may all (except the Tortoise) be traced to an exaggerated idea of the largest animals now existing in India; and he sums up as follows:§—"We have the elephant, then as at present, the largest of land animals, a fit supporter of the infant world; in the serpent *Asokee*, used at the churning of the ocean, we may trace a representative of the gigantic Indian *Python;* and in the bird-god *Garūda*, with all his attributes, we may detect the gigantic Crane of India (*Ciconia gigantea*), as supplying the origin. In like manner the *Colossochelys* would supply a consistent representative of the Tortoise that sustained the Elephant and the world together. But if we are to suppose that the mythological notion of the Tortoise was derived, as a symbol of strength, from some one of those small species which are now known to exist in India, this congruity of ideas, this harmony of representation would be at once violated. It would be as legitimate to talk of a rat or a mouse contending with an elephant as of any known Indian tortoise to do the same in the case of the fable of *Garūda*."

This evidence is drawn from the most questionable of sources; and although we quite agree with Dr. Falconer in the opinion that "Geology has never disdained to draw upon any department of human knowledge that could throw light on the subjects which it

* 'Early History of Mankind,' p. 305. † P. 336.
‡ P. 333. § P. 385.

investigates," we cannot but think that he strains the principle to the utmost by calling mythology a "department of human *knowledge.*" But accepting the evidence and the conclusion, what follows? Dr. Falconer nearly thirty years ago stated as his opinion "that the *Colossochelys* may have lived down to the human period, and become extinct since;" and he now says that this view is "reciprocal" with the one "that man had lived back to be a contemporary of the Tortoise, now proved to have been Miocene." He also urges "that the form of expression selected on the occasion was that which was least calculated to provoke ridicule, or to shock the strong prejudices on the subject which were then dominant among educated men." We should not have considered Dr. Falconer so susceptible of ridicule, so careful of offending popular prejudices, or so little amenable to the necessity of a scientific man saying and writing exactly what he means, had it not been for the publication of this sentence. His object in thus investing his writings with a reputation for ambiguity is simply to make out a good case in proof of his assertion that nearly thirty years ago Captain Cautley and himself were "occupied with the question of the remote antiquity of man in India." We are quite willing to believe that this was the case, for it is still fresh in our remembrance that it was Dr. Falconer, who drew the attention of Mr. Prestwich, Mr. Evans, and others, to the long-neglected specimens and opinions of M. Boucher de Perthes, and obtained for them the fair and careful consideration that resulted in establishing the views so long held by the distinguished Abbeville antiquary.

From the foregoing quotations, however, it appears certain that the late Dr. Falconer was of opinion that the advent of man may have taken place at so remote a period as the Miocene, though "partly from considerations of a different order." To these considerations we shall presently refer; but before doing so we must ascertain what support is yielded to his view by the discoveries detailed in Mr. Foote's pamphlet.

Very little is known of the geological age of the implement-bearing formations of Madras and North Arcot; but in the districts of Trichinopoly and South Arcot deposits supposed to be identical with them are found resting unconformably on Cretaceous strata, and overlain by the alluvium of certain rivers. All the implements, several hundreds of which have been found, are made of quartzite, which substance, Mr. Foote tells us, is the best substitute for flint in the Madras district. In form these implements correspond with many of those found in the valley-gravels of France and England; but, as will be seen by a comparison of Figs. 1, 3, 5, and 7, with Figs. 2, 4, 6, and 8 in the Plate, the Indian specimens are much less elaborate. Without an examination of a large number of specimens it would not be safe to decide whether this difference is owing to the comparative toughness of the quartzite, or to the Indian implements having been made by a less cultivated, and therefore, very possibly, a more ancient people.

Mr. Foote appears to be unacquainted with Dr. Falconer's speculation (even in the form in which it was published in 1844), as he makes no allusion to it, and mentions no facts having a direct bearing on the probable relation of the implement-bearing deposits to the Miocene period. To his mind the case is simply as follows:—Stone implements, comparable with the flint implements of Europe, occur near Madras in deposits probably identical with those which in neighbouring districts underlie the modern alluvium. Therefore the Indian deposits are contemporary with the European, and are of Quaternary age, if not more recent.

In Mr. Foote's opinion, these deposits, which are composed of Lateritic conglomerates and sands, "were deposited at the bottom of a shallow sea studded with mountainous islands, between which flowed strong and rapid currents." These islands are supposed to have been either "inhabited or visited by the people who made the quartzite implements which are at present the only record of their existence." The greatest height at which quartzite implements have been found is 370 feet, so that a considerable period of time must have elapsed since the formation of the deposit in which they occur; and presuming that the alluvial deposits overlying them are to some extent synchronous with the oldest alluvium of the valley of the Ganges, we get a more or less probable measure of their antiquity. But the lapse of time thus indicated by no means carries us back to the Miocene period, as the essentially superficial Lateritic deposits can hardly be correlated with the highly inclined Sewalik strata.

It therefore appears that from the positive facts now in our possession we are not justified in assigning a period so remote as the Miocene for the advent of man in India. We must therefore return to those "considerations of a different order" to which we have before alluded.

Dr. Falconer writes, "It is not under the hard conditions of the Glacial period in Europe that the earliest relics of the human race upon the globe are to be sought. . . . . It is rather in the great alluvial valleys of tropical or sub-tropical rivers, like the Ganges, the Irrawaddi, and the Nile, where we may expect to detect the vestiges of his earliest abode. It is there where the necessaries of life are produced by nature in the greatest variety and profusion, and obtained with the smallest effort; there where climate exacts the least protection against the vicissitudes of the weather; and there where the lower animals which approach man nearest now exist, and where their fossil remains turn up in the greatest variety and abundance."

Everyone must admit the justice of the remark that the earliest traces of man are more likely to be found in a genial than in a rigorous climate; but as regards the valley of the Ganges, according to Mr. Fergusson, but an insignificant portion of it was habitable at so recent a date as B.C. 3000. The last sentence refers to a different consideration altogether, and it will doubtless be asked by some, What bearing has it on the question? Why should we expect that man appeared first in those regions where the animals which approach him nearest now exist, and where their fossil remains turn up in the greatest variety and abundance? We are a little uncertain whether we have here a statement of extreme development opinions, clouded by the effort not "to shock the strong prejudices on the subject," which *are now* "dominant among educated men," or whether there be not some "reciprocal" view which we cannot perceive.

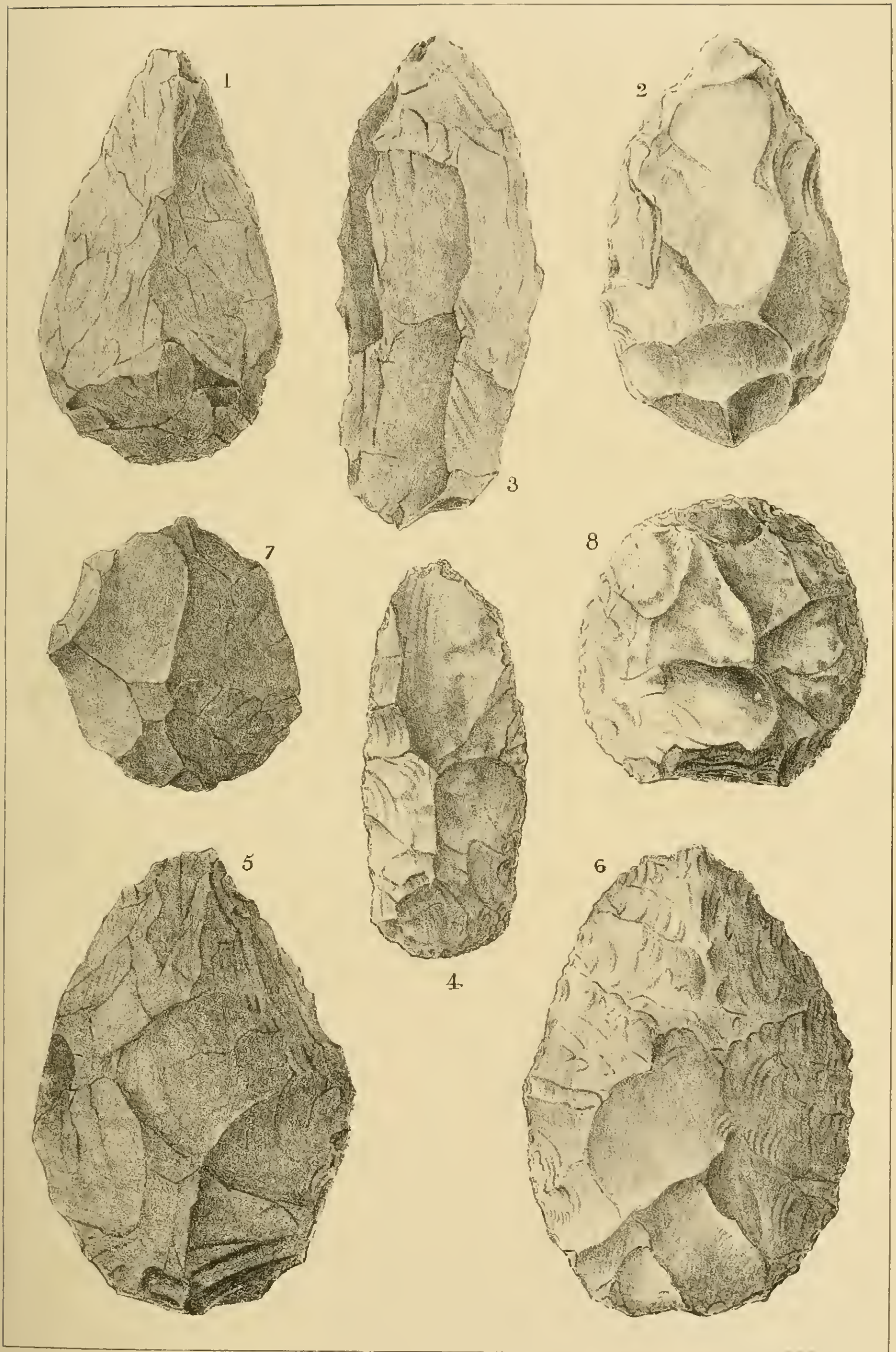
The probable origin of man could hardly fail to become a subject of speculation to those engaged in determining his antiquity; accordingly we find that several naturalists have ventured to tread on this very delicate ground. In his 'Prehistoric Times,' Mr. Lubbock has touched upon this subject, and it may be useful to cull from his pages two or three quotations containing expressions of the opinion of certain savants of eminence. Professor Huxley, for instance, has remarked that "the first traces of the primordial stock whence man has proceeded need no longer be sought, by those who entertain any form of the doctrine of progressive development, in the newest Tertiaries; but that they may be looked for in an epoch more distant from the age of the *Elephas primigenius* than that is from us." Sir Charles Lyell "thinks that we may expect to find remains of man in Pliocene strata, but there he draws the line." Mr. Lubbock combats this opinion, but does not advance any strong argument against it, though he eclipses everyone else in the candour with which he states his opinion. Thus, "it is true that few of our existing species or even genera have as yet been found in Miocene strata; but if man constitutes a separate family of mammalia, as he does in the opinion of the highest authorities, then, according to all palæontological analogies, he must have had representatives in Miocene times. We need not, however, expect to find the proofs in Europe; our nearest relatives in the animal kingdom are confined to hot, almost to tropical climates, and it is in such countries that we must look for the earliest traces of the human race."

Admitting Mr. Lubbock's premisses, man *may*, not must, have had "representatives" in Miocene times. Then "according to all palæontological analogies," the duration in time of a group of animals (whether family, genus, or order) varies inversely with its organization, so the family represented by man must have had a geologically short duration compared with that of other families of mammalia. The opinion contained in the last sentence quoted is identical with that expressed by Dr. Falconer, but it reveals more clealy the idea on which it is founded. At present man stands alone and quite isolated in the animal kingdom, and the certain records of his existence are as yet confined to Post-pliocene, probably to Post-glacial, deposits. We ought, nevertheless, to be prepared to receive facts which will extend his range in time, and lessen the gap between him and his "nearest relatives." Let us mention as two shadows, such as coming events cast before them, first, the discovery of markings on the bones of *Elephas meridionalis*, an animal of Pliocene age, supposed by M. Desnoyers and other naturalists to be of human production; and secondly, the discovery of a remarkable tooth, associated with remains of *Diprotodon*, &c., by Mr. Gerard Krefft, in an Australian cavern, which that gentleman describes as follows:*—"In shape it resembles the first of the premolar series of the lower jaw in man: the root, however, is much longer, the crown smaller, protruding, and considerably worn; the root is not smooth as in man, but somewhat ridged, with a few tubercles on the upper part." Mr. Krefft may well say, "I have no conjecture to offer as to which genus this tooth is referable."

EXPLANATION OF THE PLATE.

FIG. 1. Quartzite Implement from the Atrumpakkam nullah, one-half the natural size. (After Foote.)
" 2. Flint Implement from Icklingham, one-third the natural size.
" 3. Quartzite Implement from the Atrumpakkam nullah, one-half the natural size. (After Foote.)
" 4. Flint Implement from Milancourt, one-third the natural size.
" 5. Quartzite Implement from the Atrumpakkam nullah, unusually well made, one-half the natural size. (After Foote.)
" 6. Flint Implement from Abbeville, one-half the natural size.
" 7. Quartzite Sling Stone, from the Atrumpakkam nullah, one-half the natural size. (After Foote.)
" 3. Flint Sling Stone, from an Abbeville Tourbière, one-half the natural size.

* 'Geological Magazine,' December, 1865.



De Wilde lith.

M & N Hanhart imp.

FLINT & QUARTZITE IMPLEMENTS.

VIII. HOFMANN AND MODERN CHEMISTRY.

Introduction to Modern Chemistry, Experimental and Theoretical; embodying Twelve Lectures delivered in the Royal College of Chemistry, London. By W. A. Hofmann, LLD., F.R.S., &c.

There is no more interesting study, and certainly none more instructive, than the inquiry into the progress of that knowledge which is acquired by the aids of science. To mark, where it is possible, the first gleam of a truth, to watch the flutterings of human thought around the little light, and to follow patiently its slow and gradual development, until man seizes it aright and chains it to do his bidding, is always a delightful exercise for the well-constituted mind.

We learn in contemplating the history of scientific discovery, that the search after Truth demands a large amount of labour continuously applied. A fact may be known for ages, and remain a barren fact because man fails to interpret it correctly. The Greeks, for example, knew *Electron*—amber—they were acquainted with the iron ore of Magnesia, and they were not ignorant of their peculiar powers of attraction; but more than two thousand years passed away before man learnt those laws regulating Electricity and Magnetism, by which he was enabled to apply them to useful purposes.

Every advance made by the Human family is due to the devotion with which some chosen member of that family has solicited nature to disclose her powers. The Earth, a mass of matter of wondrous constitution, rolling along its prescribed path in space, is man's abiding place. From it he must glean everything necessary for his healthful existence, and from it he must derive every source of finite happiness. Man's prescribed task is "to possess the Earth and subdue it," and the more zealously he bends his mind to the labour, the greater is the sum of his own enjoyment, and the more numerous are the advantages which he is enabled to bestow upon his kindred. As the chaotic Earth in its early darkness "was without form and void," and as at the touch of light it became a symmetrical globe, clothed with organized forms and radiant with beauty, so brute matter is seen to develop hidden powers, under the influence of the human mind, and become at the same time useful to man.

The history of the progress of civilization—surveyed apart from all the clouding influences of political contention, religious strife and national prejudices—resolves itself into a story of man's struggle with nature. We live in an age which will ever be remarkable as a period of action, during which the human mind is taxed to the utmost to make new applications of natural forces, and new combinations of nature's elements for the use of man. Existing in the midst of the mental strife, it is as difficult to discover the real order of progress, as it is for the soldier on the battle-field to learn the fortune of the day. We can, however, examine the road over which we have passed, can remember the names of the great men who have left their footprints deeply impressed for our guidance; and gathering experience from the teachings of the past, we may venture to predicate how the future will regard the present.

The science of Chemistry specially claims our attention at this time, as ministering extensively to the requirements of man, and adding greatly to his knowledge of natural phenomena.

At the commencement of the eighteenth century, Stahl put forward his doctrine of Phlogiston, for which, perhaps, the road had been prepared by Mayow.* A phlogistic system, however, was the dawn of a new day, and the rude empiricism of previous time perished before its light. The spirit of inquiry which arose upon the promulgation of this hypothesis gradually took form, and in 1777 we find Sir Torbern Bergman writing these remarkable words:—

"We have no knowledge of bodies *à priori:* every intelligence about them must be acquired by proper observations and experiments. But to discover and pursue such experiments, as really illustrate the point we are in search of, requires not only skill and a peculiar application, but also the most impartial love of truth; in order not to be ensnared by the pleasing desire of drawing general conclusions from a few *data* of precarious certainty. It lessens, no doubt, our trouble, and flatters our vanity, to be able to disclose in a moment the whole course of nature. Man is besides naturally indolent, and much inclined to be captivated by imagination more than by reality. The confession, therefore, *that we really know no more than what we know*, is,—even in our days when the experimental method is considered as the only right and true method,—very difficult and humiliating."†

Scheele, Lavoisier, and Priestly were, however, the first who introduced the exactness of Physics—the system of observation by weight and measure—into Chemistry; and from their times it may be regarded as a new science. These philosophers gave the world many truths as the result of their modes of investigating nature, and one of them, Lavoisier, taught a chemical nomenclature, which has aided, to the present day, in the ever difficult task of expressing new ideas in a form of words which shall convey a correct impression to the mind.

Prior to, and indeed for some time after this period, although

* 'Opera Omnia Medico-physica, Hagæ, 1681.' 8vo. 'Dissertatione de Respiratione;' and also, Mayow's Diss de Salnitro and Spiritu Nitri Aereo.'

† 'Prefatory Introduction to Chemical Observations and Experiments on Air and Fire.' By Charles William Scheele. Translated by J. R. Forster, LL.D., F.R.S., &c. 1780.

Chemistry was making valuable discoveries in the mineral world, it had done but little toward elucidating any of the phenomena of the vegetable and animal kingdoms. Priestly had, it is true, discovered the influence of growing plants upon the air, and of light upon the growing plant.* Dr. Ingenhousz had observed the peculiar nature of the air "produced by a special operation carried on in a living leaf." And Sennebier found that plants yielded more "*dephlogisticated air*" (oxygen) in distilled water impregnated with "*fixed air*" (carbonic acid) than in simple distilled water.

All these men were floating round and gradually approaching the truth. Cavendish proclaimed that "fixed air is a principal constituent part of vegetable substances," but even he was bewildered by the Phlogistic Hypothesis, and it was not until Lavoisier destroyed it that any real advance was made.

Davy stands forth amidst the philosophers of his day as a remarkable discoverer. The brilliancy of his experiments, which proved the metallic nature of the earths and alkalies, and the elegance of those investigations which determined the true character of muriatic acid, has led his 'Agricultural Chemistry' to be almost forgotten. In this book, however, will be found the first clear exposition of the part which chemical forces play in all the processes of the living organisms, and an examination of the transformations and changes in plants and animals which are dependent on their influences. After Davy for a long period but small advance was made, and it is not a little curious to find Liebig in 1841 writing as follows:—

"Since the time of the immortal author of the 'Agricultural Chemistry,' no chemist has occupied himself in studying the application of chemical principles to the growth of vegetables, and to organic processes. I have endeavoured to follow the path marked out by Sir Humphry Davy, who based his conclusions only on that which was capable of inquiry and proof. This is the path of true philosophical inquiry, which promises to lead us to truth, the proper object of our research".†

It is not strictly true to say that Organic Chemistry had no existence between the time of Priestly and of Liebig. We find many chemists, as Pelletier, Vauquelin, Chevreul, Fourcroy, and others carefully examining the proximate principles of plants, and Berzelius gave the world his 'Animal Chemistry' within this period. But it must be conceded that until the Professor of Chemistry at Giessen taught Chemistry in its relations to organization and life, the study of Organic Chemistry lagged in the back-ground.

* 'Experiments and Observations relating to various Branches of Natural Philosophy, with a Continuation of the Observation on Air.' By Joseph Priestly, LL.D., F.R.S. Birmingham, 1781.

† 'Chemistry in its Application to Agriculture and Physiology.' By Justus Liebig, M.D., F.R.S., &c. 1842.

The novelty of the views put forward by Liebig; the popular style in which he wrote on what had hitherto been regarded as a recondite subject; the enthusiasm which he threw into his lectures; the novelty and the completeness of his illustrations; the boldness, approaching to dogmatism, with which he propounded his hypotheses, all tended to make Organic Chemistry the favourite pursuit of the younger chemists.

The result has been, "that, during the last quarter of a century, the science of Chemistry has undergone a profound transformation; attended, during its accomplishment, by struggles so convulsive as to represent what, in political parlance, would be appropriately termed a revolution." These are the words of Hofmann, the favourite pupil of Liebig, who was sent forth from Giessen to teach in England the doctrines of the Master.

So thoroughly has Dr. Hofmann fulfilled his mission in this country, so entirely has he identified himself with 'Modern Chemistry'—which he has chosen indeed as the title of a valuable little work from his pen—that it has been thought important to sketch the progress of this chemist, and examine, as far as our space will admit of our doing so, the value of his discoveries and their bearings upon the present state of chemical science, and its applications to manufactures.

Augustus William Hofmann, whose name must be for ever connected with the history of chemistry during the last twenty years, is the son of John Phillipp Hofmann, a German architect of repute. He was born at Giessen, Grand Duchy of Hesse-Darmstadt, on the 8th of April, 1818. His early education was received in the Gymnasium of his native town. We learn that the father, who doubtless discovered the natural powers of his son, lost no opportunity of expanding the instruction given in that school. The study of classical languages claimed predominant attention in the Gymnasium, and feeling that the practical character of the age required other kinds of learning, the architect took his son on several lengthened architectural expeditions through France and Italy. The father and son were inseparable companions, and the former thought no sacrifices too great to ensure any benefit to his boy. The education at school and that of travel, produced in young Hofmann an inclination to the study of modern languages, and created a certain facility in using them, which did not remain without influence on his subsequent career. Liebig, who beyond most men has left his mark upon the age, began to draw the attention of Europe to the University of Giessen about the time—1836—when Hofmann entered it as a student. His first year was passed in studies of a somewhat desultory character. His father desired that he should become an architect, while his own predilections were towards philology. The elder Hofmann, evidently a practical man, earnestly opposed this course, as being unlikely to lead to any definite object, or to be attended with any profitable result. After a short contest, the law was selected as the profession to which the young Hofmann was to devote his attention, and for a few years, with considerable interruptions and, according to his own confession, without any great result, the study of the law claimed the future chemist. By a combination of circumstances, such as we not unfrequently find determining a man's course in life, this career was soon abandoned.

The chemical school of Liebig had attained its highest degree of development, and from all parts of the world, ardent pupils visited the University of Giessen, anxious to study under the auspices of the great master. Young chemists, many of them having been educated elsewhere, even Professors of Universities and schools, many of whom had been teaching for years, assembled in this little German town, which for a time became the chemical centre of the world. That which must be, *par excellence*, distinguished as Modern Chemistry had its birth here, and every student who left the laboratory in which Liebig taught, took "colour like the dyer's hand from that it works in," and spread the chemical philosophy of this school over Europe and America.

Liebig's laboratory was originally the kitchen of a barracks. It was now too small for the chemical class, and it became necessary to increase the working room. At first an additional wing was added to the old building, but ultimately it was determined that the whole should be reconstructed. The construction of the Giessen University laboratory was committed to the father of the young man, who was still wavering between law, philology, and architecture. The friendly relations which ensued between the architect of the new institution and Professor Liebig soon produced its effect upon the younger Hofmann. Once drawn within the influence of an attraction, which all who have been brought within its sphere declare to be irresistible, he felt impelled with extraordinary force towards the study of nature. From this period a new life commenced; the law studies rapidly fell into oblivion, the once favourite subject of languages claimed but an occasional hour of leisure, the whole time being devoted to the study of chemistry, physics, and mathematics.

Liebig's laboratory was the first independent institution of the kind in Europe, and it has served as the model for all subsequent structures devoted to the same end. In it we see young Hofmann in rapid succession working as a zealous student and participating in his revered master's researches as an expert assistant. It is not a little remarkable that even from his *début* attention was fixed upon the young chemist, and that his first investigation should prove to be the development of a fact, which has in his latest researches reached its mature form of an important practical application.

Hofmann's first published paper was the record of an investigation into the nature of the volatile bases of coal gas naphtha, amongst which Hofmann demonstrated the presence of ANILINE. This has become the starting point of a long series of researches which have richly benefitted both theory and practice. A second paper " On the Metamorphoses of Indigo," which finally settled the question of the substitution of chlorine for hydrogen (which at the time engrossed the attention of chemists) received the prize medal of the *Société de Pharmacie* of Paris.

At this time the *élite* of young chemical Europe, the founders of Modern Chemistry were working side by side in the Giessen laboratory, and Hofmann was the favoured assistant of the master. It would be difficult to conceive conditions more inciting to work for a young *savant* than this. With a far less powerful stimulus than this, the energetic assistant of Liebig would have made his position, but, surrounded by such influences, there is little doubt that his progress was considerably accelerated. Still this enviable position could not be more than a transitional one, an important stepping-stone to further progress. The time arrived when the young assistant, anxious to obtain an independent sphere of action, had to try the strength of his own wings. In the spring of 1845, the young chemist took leave of Giessen, of Liebig, and of a delightful circle of the nearest relations and most intimate friends, and became a private teacher in the University of Bonn. Here we find Dr. Hofmann lecturing on Agricultural Chemistry, and in a laboratory of the smallest dimensions he was busily engaged in following up his experimental researches; but his stay in Bonn was not to be of long duration.

The extraordinary development which the study of chemistry, and more especially of organic chemistry, had reached in Germany by Liebeg's teaching, was not without its influence in England. In the curriculum of the English universities at this time Chemistry played an essentially subordinate part. Public laboratories in which experimental researches could have been carried out by students did not exist. Even in London and Edinburgh it was difficult at that period to get admission into a scientific laboratory for the purpose of acquiring the practice of analysis, and it could only be done at considerable cost. Consequently the study of Practical Chemistry was accessible only to a limited few. This condition, however, was not to continue much longer, and it will be interesting to trace the causes, in their operation towards producing a sensible change. The British Association was doing its work in showing the thinking portion of the British public that science was needful to them, and that a great manufacturing people could not make any considerable advances without its aid. Young Englishmen had been amongst Liebig's students; they had drunk from the earnest teacher the draughts of enthusiasm, and they returned home to spread the chemical fever, under the excitement of which they lived. In 1841 we find the British Association desiring from Liebig a report on Organic Chemistry. This was furnished to them in 1842 at the Manchester meeting by Dr. Lyon Playfair. That all may judge of the estimation in which the German chemist was then held we quote the concluding paragraph of the abstract published :—

"In the opinion of all, Liebig may be considered a benefactor to his species, for the interesting discoveries in agriculture, published by him in the first part of this report. And having in that pointed out means by which the food of the human race may be increased, in the work now before us he follows up the chain in its continuation, and shows how that food may best be adapted to the nutrition of man. Surely there are no two subjects more fitted than these for the contemplation of the philosopher; and by the consummate sagacity with which Liebig has applied to their elucidation the powers of his mind, we are compelled to admit that there is no living philosopher to whom the chemical section could have more appropriately entrusted their investigation."*

Prince Albert, who had received all the advantages of a German education, and who, consequently, had studied many branches of science, was now making the influences of his mind felt in this country. The Prince had learned to regard a knowledge of science as an essential element in a liberal education, and seeing the want of that kind of knowledge amongst the people of the country of his adoption, he lost no opportunity of enforcing its importance. The following words express, at the same time, the true condition of the period, and the high standard to which Prince Albert desired to lift the public mind :—

"Nobody, however, who has paid any attention to the peculiar features of our present era, will doubt for a moment that we are living at a period of most wonderful transition, which tends rapidly to accomplish the great end to which indeed all history points; *the realization of the unity of mankind!* Not a unity which breaks down the limits, and levels the peculiar characteristics of the different nations of the earth, but rather a unity, the *result and product* of those very national varieties and antagonistic qualities.

. . . .

"Man is approaching a more complete fulfilment of that great and sacred mission which he has to perform in this world. His

* 'The Report of the British Association for the advancement of Science for 1842,' p. 42. The full Report was embodied in two works by Liebig—'Chemistry: its Application to Agriculture and Physiology;' and 'Animal Chemistry; or, Chemistry in its Applications to Physiology and Pathology.'

reason being created after the image of God, he has to use it to discover the laws by which the Almighty governs his creation, and by making these laws his standard of action, to conquer nature to his use—himself a divine instrument. Science discovers these laws of power, motion, and transformation; industry applies them to the raw matter, which the Earth yields us in abundance, but which becomes valuable only by knowledge."*

Those words were spoken in 1850, but as early as 1844 an association had been formed under the auspices of the Prince, which proposed to establish in London a practical school of Chemistry, founded on the model of Liebig's Laboratory at Giessen, the direction of which was to be placed in the hands of a young chemist educated under Liebig's eyes.

The Council of this Association, consisting of many noblemen and gentlemen, requested Professor Liebig to propose some candidates for the office to be created. Amongst those so named by the great German chemist was Dr. Hofmann, who, in the summer of 1845, received the invitation to undertake the formation of a new school of Chemistry in England. When it is remembered that the young chemical teacher of Bonn had never visited this country, it will be readily understood that he had some hesitation as to engaging in so arduous an undertaking. This was, however, very soon overcome by the personal interest which Prince Albert took in the matter, and through the influence of the Prince Dr. Hofmann obtained from the Prussian Government an indefinite leave of absence.

In October, 1845, we find Dr. Hofmann busily engaged in arranging a small and temporary laboratory in George Street, Hanover Square, in which the new school, under the title of *The College of Chemistry*, was opened in the beginning of November. How great a desideratum was actually supplied by the foundation of the school, and how correct the judgment of its projectors had been, became obvious from the rapidity with which the scarcely-opened laboratory was filled. So great was the number of students from all classes eager to avail themselves of the newly-offered facilities for engaging in the practice of Chemistry, that the promoters of the College felt at once the necessity of providing a more permanent and a more appropriate habitation for the school. The necessary funds were immediately contributed by some of the wealthy members of the Association; and, after the lapse of less than a year since its foundation, the operations of the school were transferred to a commodious building, which had been erected in Oxford Street. This well-known building, the Royal College of Chemistry, was in full work in 1846, and when we recapitulate the

* 'Addresses delivered on different public occasions by His Royal Highness the Prince Albert.' Published by the Society of Arts. 4to edition, p. 59.

names of the men who were educated within its walls, and who have aided the progress of the science, it will be admitted that it has exerted a powerful influence on Modern Chemistry.

In proof of this, we have but to refer to the list of chemists who have worked with Dr. Hofmann at the Royal College of Chemistry, at different periods, from its opening in 1845 to the present date, and who entertained him at a farewell banquet immediately before his departure for Berlin. The names of Abel, Church, Crookes, De la Rue, Nicholson, Odling, Perkins, figure here.* Beyond this gathering we remember those of Bloxam, Noad, Galloway, and several others who have made for themselves positions in the world of science.

Amongst those who contributed towards the funds for the establishment of the College of Chemistry were many who desired some substantial return for their money in the form of lectures, soirées, analyses, &c.; and not receiving those, such contributors withdrew their support. This rendered the financial position of the College for a period doubtful; but it ultimately emerged from all difficulties, through the devotion of a few faithful friends, whose names should be held in honour. Sir James Clarke, the late Lord Ashburton, Mr. Warren De la Rue, the late Mr. Dalrymple, and Dr. Bence Jones, stood in the first rank; and their efforts were supported by the determination of Prince Albert not to shrink from any sacrifice for the sake of consolidating the school which he had founded. While referring to this period of difficulty, it is pleasant to quote the words of Mr. Warren De la Rue as Chairman at the Banquet already referred to.

"Some of us know that the ability of the promoters to perform their part of the arrangement fell very far short of their anticipations, the very existence of the College being in fact in danger, and that Dr. Hofmann voluntarily gave up in succession—first, a portion of his salary, then his share of the student's fees, and lastly his house. Yet during this trying period he never, in the slightest degree, relaxed his efforts to establish the reputation of the College. He not only gave up the money which was his due, but, out of his extreme devotion to the educational objects of the College, abandoned for some years what to a German *savant* is of still greater importance, his original scientific investigations."

This statement is essentially important as showing the firmness of faith and purpose in Dr. Hofmann, who never for one moment lost hope in the ultimate success of the Institution which he was directing.

In 1849, Dr. Hofmann was elected a Member of the Chemical

* 'Farewell Banquet to Dr. Hofmann.' A pamphlet record of this event, printed by Clowes & Sons.

Society, and on the 12th June, 1851, he was received as a Fellow into the Royal Society.

In 1853, the Chemical chair of the then recently established School of Mines, connected with the Museum of Practical Geology, became vacant by the resignation of Dr. Lyon Playfair. Sir Henry De la Beche, the Director of the School;—indeed the Founder of it; of the Museum of Practical Geology; and of the Geological Survey of the United Kingdom, offered this appointment to Dr. Hofmann. The Council of the College of Chemistry strongly urged their Professor to accept it, and they at the same time came to a resolution, to the effect that the object for which the College had been originally established having in a great measure been achieved, the College with all its property should be offered to the Government, to be incorporated with the Institution in Jermyn Street.

The negotiations to this end were carried out by the Office of Woods on the part of the Government, and brought to a satisfactory issue. Thus Dr. Hofmann became connected with the Royal School of Mines, without leaving his favourite laboratory in the College, which henceforth became the Chemical Department of the National Institution. This new position afforded Dr. Hofmann additional facilities to engage freely and largely in the experimental pursuits of his predilections.

As Dr. Hofmann has been enabled from 1853 to almost the present time, to carry on without disturbance his system of chemical instruction, and to pursue without the annoyance of the interference of shareholders his own researches, we will leave him in this happy position, endeavour to review his labours, and examine the extent to which he has aided in bringing about that state of knowledge comprehended in the term Modern Chemistry.

No inconsiderable portion of Dr. Hofmann's power arose from the zeal which he threw into his teaching; the pains which he took by enlivening experiments and new apparatus to bring forcibly to the eye of the student the facts and reactions he desired to impress on the mind. Although he never lost a strong German accent, he spoke our language with fluency and force; but the attraction of his style of lecturing consisted less in the language, than in the felicity of the illustrations, by which he endeavoured to bring the most abstract subject to the grasp of the popular understanding. He positively made the inanimate subjects he was dealing with live and act their several parts in the presence of his hearers, and he certainly was never greater than in the lecture-room. Hence his evening lectures in the Museum of Practical Geology, his lectures at the Chemical Society, of which he was president in 1861, at the Royal Institution, and elsewhere, always drew large audiences, who witnessed with pleasure and instruction the well-devised and successfully performed experiments. Even H.M. the Queen was pleased to listen to some of Dr. Hofmann's lectures, and he repeatedly had the honour of delivering short chemical courses to the Court at Windsor Castle and at Osborne.

Nothing can show more completely Dr. Hofmann's power of rendering an abstract subject pleasing than his lecture delivered at the Royal Institution on the 7th of last April "On the Combining Power of Atoms." In this lecture, which has been printed with wood-cuts, Dr. Hofmann introduced an entirely new mode of illustrating the subject. "I will," he says, "on this occasion, with your permission, select my illustration from the most delightful of games, *croquet*." He makes croquet balls represent the atom, and the atoms of different elements are distinguished by different colours. He adds another mechanical contrivance to indicate the combining power of the atoms; this is effected by screwing into the balls metallic pegs, by which they can also be joined so as to rear mechanical structures in illustration of the atomic edifices to be illustrated. "Thus the hydrogen and chlorine atoms, which are *univalent* atoms, have each *one* arm, representing one combining or attraction unit; the atom of oxygen, a *bivalent* atom, has *two*, representing two attraction units; while the nitrogen and carbon atoms, respectively *trivalent* and *quadrivalent*, are provided with *three* and *four* arms, indicating the three and four combining units respectively distinguishing the atoms." By fixing those balls together in the order in which experiment has proved to us they combine, visible representations of the compounds which result from their combination are produced. In this way instruction is afforded by reaching the mind through the eye, which would never so readily have found ingress through the portal of the ear.

From the first Dr. Hofmann fully appreciated his task. He knew that to make the College of Chemistry successful and to establish for himself a name in England, his teaching must be made to tend to practical results. While he never flinched from impressing theory on the minds of his pupils, he made them all practical workers. They learned as much by what they saw passing before them as by their own actual manipulation. Dr. Hofmann has been particularly and truly characterized by his power not only of getting into the minds of his students the utmost amount of knowledge, but by his kindly encouragement, getting the most out of them for the advancement of science. As an example of this, during the last few years Dr. Hofmann has been entirely engaged in the elucidation of the chemistry of the new coal-tar colours which have attracted so much attention. This industry has in a great measure emanated from the Royal College of Chemistry; most of those who first engaged in this new branch of applied chemistry, Messrs. Perkin, Nicholson, Maule, Simpson, Medlock, and others were pupils of the College. While Dr. Hofmann has been earnestly engaged in working out the theory of this interesting subject, he has not forgotten its practical application. The beautiful red colouring matter known as Magenta was first observed and described by him, although he never produced it on a commercial scale. Again, the splendid violet, so much in vogue at present, is a discovery of Dr. Hofmann's, who produced it by the action of iodide of ethyl upon Magenta. It is a curious coincidence that the same agent which contributed so much, as will presently be seen, to his scientific successes, should also assist him in a brilliant industrial achievement.

We must now sketch, although we can do so but briefly, the progress of scientific inquiry in Dr. Hofmann's hands.

By continuing his researches on Aniline and its derivatives, he worked step by step to a clearer conception of the relation in which these substances stand to ammonia. He proved the volatile bases to be compound ammonias, derived from ordinary ammonia gas by the substitution of compound atoms consisting of carbon and hydrogen, for either one, two, or three of the hydrogen atoms in ammonia, and he gave a method as general as simple for the artificial construction of an endless variety of these substances.*

These researches have exercised a powerful influence upon the progress of Chemistry both practical and philosophical. Iodide of ethyl, in general the iodides of the alcohol radicals, with the aid of which the new reactions were accomplished, appear in these researches for the first time as agents of the substitution of compound hydrocarbon atoms for hydrogen, and substances which had been seen by few chemists at that time, became at once some of the most frequently employed agents of research. Ever since the publication of Dr. Hofmann's Memoirs, these agents have played a most important part in all researches in Organic Chemistry, by which the most interesting theoretical questions have been elucidated, and these agents are now manufactured upon a colossal scale for industrial purposes.

Nor was the influence of this investigation upon the general progress of Chemistry less marked in Dr. Hofmann's researches on Ammonia, in which he exhibited this substance as the source of an unlimited number of derivatives similar in construction but modified

* This beautiful series of researches should be studied by the aid of Dr. Hofmann's papers, published in the following Journals :—

'Liebig's Annalen,' vol. liii., p. 1.

'Researches on the Volatile Bases,' 'Quarterly Journal of the Chemical Society,' vol. i., pp. 159–269; vol. ii., pp. 36, 104, 300.

'Researches regarding the Molecular Construction of the Volatile Organic Bases,' 'Phil. Trans.,' vol. cxli. (1850), p. 93.

'Researches into the Molecular Constitution of Organic Bases' (this paper is devoted to such as are not volatile, and continued in papers subsequently published), 'Phil. Trans.,' vol cxli. (1851), p. 372.

in properties. In these researches we find the first germ of the theory of types which subsequently in the hands of Gerhardt, Williamson, and others assumed a more general form.

We abstract some remarks from one of Dr. Hofmann's papers* which bear strongly on this point. At a very early period, as far back as 1837, Berzelius, on the grounds of Liebig's researches, expressed the opinion that the natural alkaloids which at that period engrossed the undivided attention of chemists were peculiar ammonia compounds—conjugated compounds, in which the chemical character of ammonia, modified indeed by its conjunct, was still perceptible. This view, which was principally founded on the remarkable analogy of the ammonia salts and the salts of the alkaloids, met by no means with general approbation when first started; but it has been retained and carried out by Berzelius, and it cannot be denied that since that period, science has acquired a great number of facts which powerfully support his opinion. Organic Chemistry has been enriched by a long series of artificial bases, which is almost daily being increased. These bases are formed in a variety of processes, many of which products we see generated by the direct action of ammonia on other compounds. Numerous examples are given, and Dr. Hofmann remarks:—"From the transition of these indifferent substances into bases under the influence of reagents, giving rise in so many cases to the formation of ammonia, does it not become exceedingly probable that in this case part of the nitrogen has been reconverted into ammonia, which uniting with the remaining elements has impressed its character on the whole compounds?"

To these investigations may be referred Gerhardt's classification. Mr. G. C. Foster† says, "The reconciling of the theory of types with the theory of compound radicals, which resulted from the discovery of the compound ammonias by Wurtz and Hofmann, and the discovery of the mixed ethers (or ethers containing two distinct alcohol radicals) by Williamson, prepared the way for Gerhardt's classification of chemical substances, according to the types of double decomposition."

It must not be forgotten that in the memoir published in the 'Philosophical Transactions' already referred to, will be found the first typically written formulæ. Researches of this high character leading to such important results in the philosophy of a science could not fail to earn for their author substantial acknowledgments. The interest taken by the Royal Society was evinced by two successive grants of large sums of money during the progress, and to

* 'On the Action of Chloride, Bromide, and Iodide of Cyanogen on Aniline,' 'Quarterly Journal of the Chemical Society,' vol. i., p. 285.

† 'British Association Report: 29th Meeting at Aberdeen, 1859,' p. 1. This report is deserving of careful study.

meet some of the expenses, of this inquiry. The Royal Society also awarded to Dr. Hofmann their Royal Medal on the completion of the investigation. In rapid succession the fortunate experimenter became a Correspondent of the Institute of France (which conferred upon him moreover the great prize, value 5,000 francs), and of nearly all the academies and learned societies of Europe and America.

During the period between Dr. Hofmann's becoming Professor of Chemistry in the Royal School of Mines and his return to his native country, numerous researches were carried forward and records of them published; amongst others may be especially named his 'Memoirs on the Phosphorous Bases and the Polyammonias.'*

This is a bald outline of the treasures added by Dr. Hofmann to the rich harvest of discoveries which of late years have rewarded the exertions of chemists. With reference to their general effect on the progress of the science, we cannot avoid recognizing, as one of the most valuable amongst its acquisitions, the development of the theory of polyatomic compounds. The names of other great chemists are of course associated with the advances which have been made; and in confining our notice to the labours of Dr. Hofmann, it must not be supposed that they have been forgotten. We have been writing, not a history of modern chemistry, but a concise statement of the part which one man has taken in this fertile field of discovery.

Beyond the inquiries to which we have referred, we find Dr. Hofmann engaged in many others of a strictly practical nature.† As a juror Dr. Hofmann heartily co-operated in the three International Exhibitions, and the reports which he furnished are generally valued. It is not easy to conceive anything more complete,

* The Memoirs which have appeared since this period in the 'Philosophical Transactions' are :—

"Researches on the Action of Sulphuric Acid upon the Amides and Nitrites, together with Remarks upon the Conjugate Sulpho-Acids," June 12, 1856. In this paper Mr. George Buckton is associated with Dr. Hofmann.

"Researches on a New Class of Alcohols," June 18, 1857. Vol. cxlvii., p. 555. In this Dr. Hofmann is associated with A. Cahours.

"Researches on the Phosphorus Bases," June 18, 1857. Vol. cxlvii., p. 575.

"Contributions to the History of the Phosphorus Bases." First Memoir.

Ditto. ditto.
"Theory of Diatomic Bases—Diphosphonium Compounds." } Second Memoir.

Ditto ditto.
"Phosphammonium and Phospharsonium *et* Diarsonium and Arsammonium Compounds," June 22, 1860. Vol. cl., p. 409 *et seq.* } Third Memoir.

† Hofmann and Graham—"Report on the Alleged Adulteration of Pale Ale by Strychnine."

Hofmann, Graham, and Redwood—"Report upon 'Original Gravities.'"

Hofmann, Graham, and Miller—"Chemical Report on the Supply of Water to the Metropolis."

Hofmann and Witt—"Report on the Metropolitan Sewage Question."

as it respects the state of chemistry in 1862, than the Chemical Report on the Exhibition of that year.

The "Introduction to Modern Chemistry" which Dr. Hofmann has given us, on the eve of his departure from this country, is another choice example of the completeness of all his works. It is a clear and concise explanation of the most recent views entertained by modern chemists, and of the experimental proofs by which they are supported. It should be in the hands of every young student of the science.

Dr. Hofmann, after having repeatedly declined invitations to return to his native land, has at last yielded. The Prussian Government conceived the idea of erecting in the University of Bonn,—which is the scientific centre of the Western Provinces of the kingdom,—a Chemical Institution on a grand scale, intended, not only to supply the wants of the University, but calculated also to advance the rapid growth of the industrial interests of the surrounding provinces of Rhineland and Westphalia, which have, not inappropriately, been called the Lancashire of Germany. The invitation to organize the new institution, for which most ample funds have been provided by the Chambers, coming as it did from the university in which so many years ago he had commenced his professional career, proved irresistible to Dr. Hofmann. In 1863 he undertook an extensive journey through nearly all the European Universities in which chemistry is prominently taught, for the purpose of collecting the needful preliminary information. The data thus gathered he embodied into an elaborate plan, going into all the numerous mechanical details involved in the prosecution of modern chemistry. This plan was adopted by the Prussian Government, and the magnificent buildings, exclusively intended for the advancement of chemical knowledge, and which promise to become a model laboratory, are now rapidly approaching completion.

While things were thus moving forward in the Rhineland University, an event occurred which was to influence and deeply to modify all the plans which Dr. Hofmann had formed with regard to Bonn. At the end of 1863 the celebrated Mitscherlich died at Berlin. Early in 1864 the Senate of the University of Berlin elected Dr. Hofmann to become his successor. The Prussian Government sanctioned this election, and charged Dr. Hofmann with the organization in Berlin—as the scientific centre of the Eastern provinces—of a laboratory similar to that of Bonn, leaving him the option after the completion of the two Institutions of taking up his abode at either one or the other of these cities.

In the summer of this year, Dr. Hofmann left London for Berlin. On the 28th of April a farewell banquet was given to him by "a number of gentlemen who had worked with Dr. Hofmann at the Royal College of Chemistry," and every one, from the Comte de Paris to the youngest chemist present, expressed their sorrow at the departure of their master, and their hopes that his absence from the land of his adoption would not be a prolonged one.

This notice of one of the men foremost in advocating those new doctrines which distinguish Modern Chemistry, and which are now acquiring an ascendency throughout Europe, cannot be more appropriately concluded than by borrowing a few thoughts from the last lecture delivered at the Royal Institution by Dr. Hofmann.

The intricate formulæ of the modern chemists, and the boundless variety of the phenomena which they illustrate, were not long since like an impassable labyrinth; but Dr. Hofmann has given us a clue, and a sense of mastery and power succeeds in our minds, to the sort of despair with which we first contemplated this tedious category. By the aid of a few general principles, however, we are now able to unravel the complexities of these formulæ, to marshal the compounds which they represent, in an orderly series, to multiply their numbers at will, and in a great measure to forecast their nature ere we have called them into existence. The great movement of Modern Chemistry is "a movement as of light spreading itself over a waste of obscurity, as of a law diffusing order throughout a wilderness of confusion, and there is surely in its contemplation something of the pleasure which attends the spectacle of a beautiful daybreak, something of the grandeur belonging to a world created out of chaos."

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

The whole agricultural interest of the quarter has centred in the progress of the cattle plague, to which reference is made in another page. We add to the details there given that the number of the new cases reported to the Veterinary Department of the Privy Council, which was only a few hundreds weekly in the early part of autumn, reached 2,600 in the week ending November 18th, 3,600 in the week ending November 25th, 3,800 in the week ending December 2nd, and upwards of 5,000 in the week ending December 9th.

We do not know how local fears may have exaggerated in the instances out of which these aggregates arise; but any discount which such a consideration as this might justify is more than balanced by the large number of cases in which losses by the plague are concealed, in order to escape the exercise of the stringent powers which have been vested in inspectors.

No treatment, allopathic, hydropathic, or homœopathic, has been hitherto successful. The proportion of recoveries has not been influenced by any cause which has yet been put in operation, though no doubt good nursing must help the patient through when the vital energy would otherwise be barely overcome.

In connection with the cattle disease and the London cowhouses, where it first appeared, a paper on London Milk has been read by Mr. Morton before the Society of Arts, in which he declares that, coming to the examination of the subject with the prejudices of a countryman that London cowhouses are an abomination, that Londoners are ill fed with milk, and that the right way to supply a town with milk is to bring it in from the country,—he has come round to the conclusion that London cowhouses need not be a nuisance, that London is better fed with milk than the average of south country villages, and that the right way to ensure a supply of good milk to any considerable body of people is to have it produced as near as may be to their own doors. The analyses made by Dr. Voelcker, for the purpose of this paper, prove that the milk consumed in London is very much diluted, but they also prove that water is the only diluent employed, and that all the stories about chalk and "brains" and mucilage of various kinds are fiction. The difficulty connected with a supply of milk to London from the country arises out of the extreme facility with which milk sours and becomes offensive in hot weather. The ordinary milk-can carried on an ordinary railway truck is not to be depended on for delivering its contents sweet at the end of a journey of sixty miles in summer time. And although it appears at first as if it were wiser to carry fifteen or twenty pounds of milk from the farm to the town than to carry the hundredweight of food out of which it is made as far to a cowhouse in the town, yet dealers in milk will give so much more for the townshed milk than for the country milk, that there is a great profit and advantage to all concerned in carrying the larger weight, though it be of course at a greater cost.

II. ASTRONOMY.

The President of the Astronomical Society, Warren De la Rue, F.R.S., has communicated some observations of the partial eclipse of the moon, of October 4, 1865. On the occasion of a former partial eclipse—*viz.* that of February 27th, 1858—several photographs were obtained of the moon, and he was led to suspect the existence of an anti-actinic influence extending beyond the limits assignable to the penumbra. To ascertain whether any such influence really exists was the principal object on the present occasion. Operations were, therefore, commenced some little time previous to the first contact of the penumbra; and the night at Cranford being very bright, and the atmosphere tolerably steady, photographs of the moon were obtained with an exposure of from one to three seconds, using for that purpose Steinheil's silvered glass mirror of 13 inches aperture and 10 feet local length; the action of which however was not more rapid than that of the speculum-metal mirrors (of the same dimensions and focal length), which had been hitherto chiefly used in celestial photography. After contact, it was found that an instantaneous exposure sufficed to give a faint impression of that portion of the lunar disk not obscured by the umbra, or penumbra, an exposure of a whole minute failed to bring out the portion of the lunar surface covered by the umbra, although its details were plainly perceptible in the telescope. The obscured portion of the moon was, moreover, perfectly visible without optical aid. To the naked eye, and even in the finder, the dark limb of the moon appeared to be bounded by a silvery thread of light; but this illusion disappeared under powers of 90 and 140, both in the reflector and in 4 1-8th inch Dallmeyer. The umbra towards the moon's limb had a coppery glow, while that towards the penumbra was of an ashy grey colour. The penumbra could be much better traced when the image was projected on a screen placed in the focus of the reflector than when viewed directly through the eye-piece; and probably—though this experiment was not tried—the projection of an enlarged image of the penumbra by means of the eye-piece would still further have enhanced the distinctness of view. As the penumbra gradually encroached on the disk, it was remarked that the various details of the lunar surface came out much more distinctly than when seen under the full and direct illumination of the sun; and but for the intention to devote the telescope for the time being solely to photography, some noteworthy observations could have been made respecting the configuration and appearance of lunar objects under the peculiar circumstances of an eclipse. Seventeen photographs were procured between 7h. and 11h. 5m., this interval of time commencing nearly an hour and a half previous to the first contact of the penumbra, and concluding 25 minutes after the greatest phase. At the discontinuance of the observations the night was still bright.

The photographs of February, 1858, stand in the stereoscopic relation to those of October, 1865—*i. e.* they combine in the stereoscope and produce good stereoscopic pictures of a lunar eclipse. Also, to our eyes, two pictures taken at different epochs of the late eclipse, when viewed in the stereoscope, while they necessarily show the moon as a flat disk, do yet present the shadow as raised or protruded, giving in fact the impression of a flat picture of the moon covered by a glass shade. This impression, however, is not conveyed to all observers.

Below we give a brief account of the most noteworthy photographs which Mr. De la Rue succeeded in taking during the continuance of the eclipse.

Picture No. 5, taken at 8h. 19m. 7s. (exposure one second), shows no appearance of the penumbra. The first contact of the real penumbra occurred, according to the 'Nautical Almanack,' at 8h. 25m. 54s.; and he had anticipated the possibility of being able to trace some anti-actinic effects beyond its limits; but the expectation was not realized.

Picture No. 6, 8h. 29m. (exposure two seconds), penumbra just traceable; the first contact of the moon with the penumbra occurred about three minutes before the epoch of this picture.

Picture No. 9, 9h. 21m. 29s. (exposure two seconds). The elliptical projection of the cone of the penumbra well marked, commencing close to the south pole, and traceable over Malapert, Cahous, Short, Moretus, Gruemberger, over the centre of Clavius, skirting Longomontanus, over Hainzel, covering Vitello, on the border of Mare Humorum, over Vieta and Byrgius, and passing off at the 20th parallel of south latitude on the western limb. No part of the umbra was then on the moon's disk, and the whole contour of the moon is visible on the photograph.

Picture No. 10, 9h. 38m. 58s., about 46 seconds after the first contact of the umbra (exposure three seconds), the moon's surface is invisible in the photograph to a small extent beyond the boundary of the umbra, which gradually softened off into the penumbra. The truncation of the cones of the umbra and penumbra is seen in perspective as well-marked ellipses.

Picture No. 11, 10h. 41m. 17s. (exposure three seconds), a little later than the middle of the eclipse, which occurred 1m. 42s. earlier. The obscuration of the umbra and penumbra extends in a curved line, commencing in their visible effects on the photograph at the parallel of 15° south latitude on the western limb, passing over Langrenus, Goelenius, Guttemburg, Capella, Theophilus, Kant, Dollond, Albategnius, Ptolemæus, Parry, Bonpland, Euclides, above Flamsteed, and passing over the southern limb of Grimaldi, above the parallel of 10° of south latitude.

Picture No. 16, 12h. 54m. 12s., was exposed exactly one minute, ending at the above-named time; the unobscured portion of the moon was completely solarized, and the details in consequence lost; yet not the slightest trace of any part of the lunar disk was depicted within the limits of the umbra. The next picture was instantaneous, the exposure certainly being less than a quarter of a second, yet the whole of the unobscured surface is clearly though faintly depicted.

The Astronomer Royal has published a long paper on the value of the moon's semi-diameter as obtained by the investigations of Hugh Breen, Esq., from occultations observed at Cambridge and Greenwich.

A proposal having been made by Mr. Breen to extend the reduction of the occultations observed at Greenwich, it was suggested by Professor Airy that the occultations, in their reduced form, as exhibited in the 'Greenwich Observations,' might be used for the determination of the semi-diameter of the unilluminated moon. Mr. Breen accepted this suggestion, and the Admiralty sanctioned the undertaking and supplied the necessary funds. Mr. Breen determined on applying his computations to the occultations observed at the Cambridge Observatory during the Astronomer Royal's presidency over that Institution, ending with 1835, and to those observed at the Greenwich Observatory from 1836 to 1860.

Mr. Breen originally included in his computations the occultations of every class. But viewing the causes of inaccuracy of various kinds attending the occultations of planets—the uncertainty of the planet's place for the day, the uncertainty of the planet's semi-diameter, the difficulty of correction for phase and the general rudeness of the observation—it was thought best to strike out the planets and to confine the investigations to stars.

The results were divided into four classes:—

I. Disappearances of Stars at the Dark Limb; II. Disappearances at the Bright Limb; III. Reappearances at the Dark Limb; IV. Reappearances at the Bright Limb. The following are the means of results for Occultation-correction for the Final Telescopic Semi-diameter in the four classes:—

I. Disappearances of Stars at the Dark Limb:
Mean from 130 occultations . . . . . $-1''{\cdot}98$
No observations excluded.

II. Disappeara ces of Stars at the Bright Limb:
Mean from 51 occultations . . . . . $-0''{\cdot}65$
Four observations excluded.

III. Reappearances of Stars at the Dark Limb:
Mean from 64 occultations . . . . . $-2''{\cdot}32$
Ten observations excluded.

IV. Reappearances of Stars at the Bright Limb:
Mean from 50 occultations . . . . . $+1''{\cdot}38$
Eleven observations excluded.

From the nature of the observations, the first and third of these means are very far superior to the second and fourth, and the first is greatly preferable to the third. We cannot be sensibly in error in saying that the moon's Occultation Semi-diameter is less than the moon's Telescopic Semi-diameter by $2''{\cdot}0$.

Mr. De la Rue, from his photographs taken during the eclipse of 1860, obtained the following corrections to the Telescopic Semi-diameter:—

By the differences between observed and tabular distances of centres, deduced from the measurements of peripheries, and of the measures of cusps of *all* the photographs. . . . . . $-2''{\cdot}1$

By the times of first and last contact, deduced from the measurements of the distances of the peripheries in the photographs taken near these epochs . . . . $-2''{\cdot}2$

By the times of first and last contact, deduced from the measurements of the distances of the peripheries *and of the cusps* in the photographs taken near these epochs . . . . $-1''{\cdot}0$

Mr. T. Fletcher, of the Tarnbank Observatory, has drawn the attention of those astronomers who are in possession of large telescopes, to the present condition of that most remarkable star ζ *Herculis.* With his large refractor of 9½ inches aperture and a power of 1,000 it is absolutely single. A few years ago, he had no difficulty in measuring it both in position and distance with a telescope of 4 in. aperture only. As the companion star is undoubtedly close upon its perihelion, the earliest possible observation of its reappearance will be of great value in the determination of its orbital element. Mr. Dawes states that *last year* he found the star quite single.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

Mr. Gulliver continues his researches among raphides, and brings out some curious results. In Vitaceæ he finds them universally present, while in Lindley's Berberal alliance, the allied orders placed round Vitaceæ are apparently universally devoid of them. Thus also *Leea*, placed by Lindley under Vitaceæ, contrary to the opinion of Von Martius and others, contains raphides like other Vitaceæ, which order appears to be as truly a raphis-bearing one as Balsaminaceæ, Onagraceæ, &c., are; and thus the importance of these minute organs becomes apparent. In a later contribution to the subject, he has continued his remarks, and finds that in every genus of Vitaceæ examined there were traces of raphides, except in Bersama and Natalia, in which raphides are replaced by crystal prisms having four equal faces, their ends sloping off, either from angle to angle or from face to face. The same interchange occurs also in Roxburghiaceæ (Dictyogeneæ). The Araliceæ abound in sphæraphides but are destitute of raphides, while Pandanaceæ, like the rest of Lindley's Aral alliance, abound in raphides.

In the 'Comptes Rendus' M. Boussingault describes some experiments upon the functions of the leaves of plants, the results of which appear to be:—1st. That leaves exposed to the sunlight do not decompose pure carbonic acid, or if they do, they do it with extreme slowness; 2nd. Under the same circumstances in a mixture of carbonic acid and atmospheric air they decompose the acid rapidly. The atmospheric air appears to have no active part in this phenomenon. 3rd. Leaves exposed to the sun rapidly decompose carbonic acid, when mixed either with nitrogen or with hydrogen. Although the decomposition of the acid is a phenomenon of dissociation, M. Boussingault traces a pretty close analogy between it and the slow combustion of phosphorus.

Mr. Roland Trimen gives in the 'Linnæan Journal' an account of the structure of Bonatea speciosa, a Cape orchid, from which it appears to be eminently adapted to insect fertilization, so that probably the length of the nectary and the amount of nectar it contains are so contrived as to necessitate the hungry visitant's probing even its head into the rostellum cup in order to obtain the sweet fluid, in which case the attachment of one or both of the viscid disks to some portion of the underside of the head or proboscis seems inevitable. The most remarkable point in the structure of this orchid is undoubtedly the erect process of the labellum. Its sole use and object are unmistakable, and its abrupt prominence seems so foreign to the general character of the labellum and petals, that it would be difficult to find, even in the orchidean order, a more striking instance of special modification. With the exception of this local development of the labellum, no part of the perianth appears to conduce directly to the fertilization of the flower, but the extraordinary modification of the columnar organs effects what is required. The lateral petals, which in so many South African Ophreæ are of the utmost importance, are of no direct service in Bonatea. The prominent and magnificent group of cohering sepals and petals appears to serve the purposes of protecting and supporting the stigmatic processes, and of affording a convenient landing place for insects. Possibly, too, its singular form may give it some attractive influence. It may be added that Mr. Darwin especially directed Mr. Trimen's attention to this species, and requested him to investigate its structure, but Mr. Trimen's observations have hitherto only been made upon cultivated specimens, and the evidence is, therefore, not quite perfect.

Dimorphism, to which attention has so often been directed of late, has been found by Dr. Dickie to occur in Eriophorum angustifolium. In the neighbourhood of Aberdeen, he observed in May that there were obviously two forms of flower, one with slender spikes, having only stigmas visible; the other, with shorter and blunter spikes, with very prominent anthers and short stigmas. In the first, on dissection it was found that in each flower there were three stamens in a rudimentary condition, which remained so till the end of the month, when there was still no pollen in them; while in the second form the anthers were large and prominent, yielding copious pollen; the stigmas were shorter than the stamens, but were apparently well formed, although shrivelled; they had evidently exercised their special function, and this at the time when the stigmas of the other form were still fresh and their tissues full of fluid. In both forms the seeds apparently reached their full ripeness, and on dissection there was no apparent difference, and about forty seeds of each form were sown under precisely the same conditions. Almost every seed of them from plants with large anthers and short stigmas sprang up and continued to grow; while not more than five or six of the seeds from the other form showed any sign of life. The experiment was repeated with the same result. Dr. Dickie adds that having examined some duplicates of this species from the shores of Davis's Straits, he finds that they also have the two forms.

The Imperial Society of Natural Sciences at Cherbourg have proposed a prize question for the year 1868: "Sea-wrack, considered with reference to Agriculture and Industry." The prize will be a Gold Medal of the value of 500 francs.

M. Lestiboudois continues his investigations upon the fluids of plants, in the 'Comptes Rendus,' his latest being with reference to the existence of solid and liquid matters in the *tracheæ*, which are usually supposed to be reservoirs of air. These liquids, however, being perfectly clear, may be ordinarily invisible; moreover, when separated from the plant, air would readily find its way into them. He maintains that there is no proof that tracheæ are exclusively tubes for the conduction of gases. In their youngest condition the trachean vessels are found to be full of fluid, like the other elementary organs, though this fluid appears to be lost at a more advanced stage. He believes, however, that they are still traversed by denser liquids, and his observations go to prove that these liquids may become so much thickened as ultimately to fill up the cavity and obstruct the circulation. Thus, in the stem of the Rotang he found that the great vessel occupying the centre of most of the bundles was filled with a solid white material, with cylindrical masses sometimes continued, sometimes broken up, and which broke up into granules when immersed in water, the granules having a very active movement, although the vascular tissue had long been dried up. In a vine stem also, cut into short pieces, a transparent matter of the consistence of gum was found to exude in abundance from the cut surfaces in a very short time. Smaller sections being cut, he found the next day that in the mean time gummy filaments had protruded from the large vessels, from which he infers that the tracheæ, even in old plants, contain matters of considerable density as well as the aëriform substances which are usually considered to be their sole contents.

M. Caspary describes an organ in plants which he terms the protective sheath, consisting of a layer of very closely approximated cells placed in a single series in thickness. which protects the vascular system of the stem, roots, and leaves. In some cases, however (as in Berberis), this layer is ruptured during its growth, and consequently does not serve to protect the organs which it envelopes. He observes certain folds upon the cell walls of the protective sheath of Ficaria ranunculoides, &c., which at first appeared to be pores, but when the cells of the protective sheath become thickened these folds gradually disappear, a change which he attributes to the elongation of the walls of the cells. This protective sheath has been regarded by M. Karsten as a lignified residue of the layer of cambium, which has produced the other parts of the stem; but M. Caspary controverts this, and also maintains that the entire terminal bud is formed of cambium, and already contains the mother-cells of all other kinds of tissue which will subsequently form the various parts of the stem, against the opinion which derives all the parts of the stem from a single layer of cambium existing in the terminal bud. (For an abstract of his paper, see 'Annals Nat. Hist.')

In the 'Comptes Rendus' M. Fournier makes some observations upon the fruit of the Cruciferæ, which tend to throw additional light upon its construction, and show that it is to be regarded as formed of two carpels alternate with the placentas, and of two intervalvar placentæ, from which the septum issues on each side, and by a double origin.

M. Naudin, "the most distinguished experimental fertilizer on the continent," has sent to the 'Natural History Review' a paper in which, after remarking upon the well-and-long-known facts of the variability of cultivated plants, and their tendency to give rise to secondary or derivative forms, he expresses his opinion that this phenomenon is not limited to cultivated species, but considers it infinitely more probable that it has taken place in nature on a much wider scale than in the narrow domain of our industry; and that the best characterized species are so many secondary forms, relatively to some more ancient type which actually comprised them all, as they themselves comprise all the varieties to which they give birth under our eyes, when we submit them to cultivation. He then dwells upon the fact that, variable as are vegetable forms, they have a strong analogy with each other, which is explicable upon the system of common origin and of the evolution of forms. There are seven or eight hundred kinds of Solanum disseminated over an immense extent of country in the Old and New Worlds; all are specifically distinct, but all resemble each other in a certain sum of common characters, and the view that this relationship is of derivative origin, he says he expressed in 1852, when he said (Revue Horticole):—"We do not believe that nature proceeded in the formation of species, in any other manner than we ourselves proceed to form varieties." He now states his belief in the unity of origin and in the derivation of living beings from the same branch, and by consequence in a single focus of creation, whence the stocks of these great branches have been elaborated from a common nucleus: and that the multiplied forms, during the process of multiplication in the course of ages, have always followed divergent paths, and that in consequence it is contrary to nature to suppose that species can be changed the one into the other, or that two species can be melted into one by hybridization. M. Naudin's opinions will be received with respect, but inasmuch as he merely indicates his belief in derivation of species without assigning any physical cause, they can only be regarded as confirmatory of the Darwinian theory, and not in any manner as independently originating it.

A remarkable circumstance in the history of Lichens has been brought before the Natural History Society of Dublin by Admiral Jones. It is the discovery of spiral vessels in the thalles of Evernia prunastri. Dr. Moore saw them and expressed his belief that there was no doubt of the fact. Spiral vessels had been found in certain fungi, and analogy would lead one to suppose they might possibly be met with in lichens. Mr. Archer considered the vessels in question as neither annular nor scalariform, but truly spiral, and where through the brown cellular mass he had been able to trace the ends of the fibres, he found that they gradually tapered, and in one instance one had been broken off by pressure and the fibre uncoiled. There was a peculiarity about these vascular bundles, *viz.* that certain of them, running up and down parallel with the other vessels of the bundle, upon meeting did not overlap, but suddenly diverged at right angles from the rest, and were prolonged in a direction vertical to them, the whole bundle having a T-like form.

Botanical Science has sustained lately two great losses in the deaths of Sir W. J. Hooker and Dr. Lindley. The former, as Director of Kew Gardens, has long been known as a scientific botanist of eminence, and the father of a greater botanist, Dr. J. D. Hooker, who succeeds him. Dr. Lindley long filled the chair of Botany at University College, and but recently retired from that position, to be succeeded by Mr. Oliver. Dr. Lindley's works upon his favourite science are justly celebrated—his 'Vegetable Kingdom' being the most comprehensive condensed account of the subject in our language. Few English botanists equalled Dr. Lindley in the acuteness of his scientific views and the perspicuity of his writings.

IV. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

There is but little of general and popular interest to chronicle this quarter in the progress of a science which nevertheless goes on developing itself at a rate unparalleled in the history of any other branch of knowledge. A Registrar-General of Chemistry might present us with a list of the new compounds born perhaps daily in the laboratories of the numerous chemists who are devoting themselves to the science ; but our limits will not allow us to assume the functions of such an official, and we must content ourselves with presenting our readers with a short account of those discoveries which have a general and practical interest rather than those, however valuable, which have a purely scientific bearing.

Following the usual order, and adopting the now almost discarded distinction between organic and inorganic chemistry, we may first refer to the discoveries in the latter branch. And first among these we must mention the announcement made by Dr. A. W. Hofmann, at the meeting of the British Association, of the discovery, by Lossen, of a series of bodies intermediate between nitric acid and ammonia. In the reaction of nitric acid upon certain metals it is well known that ammonia is formed; Lossen, however, has shown that the ammonia is only the final product of the reaction, and that a whole series of intermediate bodies existed between the nitric acid and the last product of its reduction. One of these bodies Lossen has succeeded in isolating, and has found it to have the formula H_3NO. It may, therefore, be regarded as protoxide of ammonia, or, more scientifically, as ammonia in which one atom of hydrogen is displaced by the residue of water HO, *hydroxyl*, as it has been called. Viewed in the latter light, the new body may be termed *hydroxylamine.* Like ammonia it combines with acids, and yields a series of magnificent and easily crystallizable salts. As Dr. Hofmann remarked, it is interesting to see the simplest (?) of reactions familiar to every chemist still yielding a harvest of such splendid results.

Since the above was written we have seen* an abstract of the memoir on the subject presented to the Berlin Academy by Dr. Lossen. In this we find the method of preparing hydrochlorate of hydroxylamine. Five parts of nitric ether, and 12 parts of tin are added to 50 parts of hydrochloric acid, sp. gr. 1·124. The mixture soon becomes hot, and hydrogen is evolved. When the reaction has terminated, the tin is removed from the solution by means of sulphuretted hydrogen, and the filtered liquor is evaporated. Sal-ammoniac first crystallizes out, the hydrochlorate of hydroxylamine being extremely soluble in water. The two bodies may be completely separated by dissolving both in absolute alcohol, and precipitating the sal-ammoniac with chloride of platinum, with which the hydrochlorate of hydroxylamine does not combine.

We may here mention some experiments of Dr. Wetherill on ammonium amalgam,† which tend to disprove the existence of the compound metal NH_4. Referring the reader to the paper indicated below, we need only state that the author's experiments have led him to the conclusion that the so-called amalgam is not an alloy of mercury and ammonium, but merely a mass of mercury distended by bubbles of ammoniacal gas.

A very interesting experiment devised by Kraut is described in the 'Annalen des Chemie und Pharmacie' for October, and will be found in the 'Chemical News.'‡ The author hangs a platinum spiral in an open wide-mouthed flask containing so much strong ammonia, that the liquid nearly reaches to the end of the spiral. Having made the spiral and the ammonia hot, he passes a stream of oxygen through the liquid. The active decomposition of the ammonia, which now takes place, soon brings the platinum spiral

* 'Chem. Central Blatt,' No. 61, 1865, p. 970.
† 'Chemical News,' vol. xii., p. 207. ‡ Vol. xii., p. 231.

to a bright red heat, and the mixture of gases is exploded. The explosion reduces the temperature of the spiral for a moment, but the action proceeding, the wire is again made red hot, and another explosion is produced; and so on as long as the experimenter wishes. By introducing a very rapid stream of oxygen near the level of the ammonia, and close to the spiral, a continuous combustion may be kept up, producing the long-drawn sound which is heard when a jet of hydrogen is burned in a vessel of oxygen.

In the first stage of this reaction before the ammonia is made hot, Kraut shows that the ammoniacal vapours are oxidized, and nitrous acid produced, which combines with undecomposed ammonia to form the nitrite.

Very recently* Wöhler has stated that nitrous acid is also formed when ammonia is oxidized by means of permanganate of potash. The decolorized solution filtered from the precipitated hydrated peroxide of manganese and evaporated, yields a mixture of carbonate and nitrite of potash, the latter shown by the evolution of red vapours on the addition of an acid.

Mitscherlich and Diacon have discovered simultaneously a means of detecting chlorine, bromine, and iodine in the presence of each other, by the aid of the spectroscope. Their observations will be found described in a subsequent place; but we may state here that the first-named author announces that his experiments have led him to the conclusion that nearly all the metalloids are compound bodies. At present, however, he brings no observations in support of the statement.

In the department of purely organic chemistry, the synthetical researches of Messrs. Frankland and Duppa on Ethers, deserve the first mention. In their last communication to the Royal Society, these gentlemen described the action of sodium and iodide of ethyl on acetic ether, and explained the formation of ethylic diacetone carbonate, and ethylic acetone carbonate, colourless transparent fragrant liquids, which treated with caustic baryta yield—the first, diethylated acetone; the second, ethylated acetone. The former of these has a powerful odour of camphor; the latter possesses a powerful and agreeable smell, in which the odour of camphor is slightly perceptible. We look on these bodies as objects of great interest, and it is perhaps among such that a liquid will one day be discovered possessing all the advantages, but free from the dangers of chloroform. In the same paper the authors describe the action of sodium and iodide of methyl upon acetic ether, by which a series of bodies completely homologous with the above is obtained.

* 'Annalen des Chemie und Pharmacie,' November, 1865, p. 256.

M. Campisi has announced* the formation of a new organo-metallic body, a compound of mercury with benzyl H $(\text{C}_7 H_7)_2$. The author has not yet published the process by which it is prepared.

It must suffice to mention the discovery by MM. Friedel and Crafts of a new alcohol, in which a part of the carbon is replaced by silicium,† a discovery which adds another illustration of the resemblances in the chemical behaviour of carbon and silicium.

Among the few practical improvements in manufacturing chemistry published we find a ready method of converting gallic into pyrogallic acid. By the usual process, that of sublimation, it is well known that only from 30 to 40 per cent. of the gallic becomes changed into pyrogallic acid, the remainder being lost in the empyreumatic matters generated. MM. V. De Luynes and Esperandieu therefore heat the gallic acid with water under pressure up to 210° C. for about an hour-and-a-half, and so obtain a solution containing exactly the theoretical amount of pyro-acid, which ought to be yielded by the amount of gallic acid employed.

M. Pelouze has published a method of making a glass which is said to exceed in beauty Venetian aventurine. He fuses together 250 parts of sand, 100 parts of carbonate of soda, 50 parts of carbonate of lime, and 40 parts of bichromate of potash. The resulting glass contains from 6 to 7 per cent. of chromium, about one-half of which is combined with the glass, communicating a magnificent greenish yellow colour, while the other is distributed through the mass in the form of extremely brilliant crystalline scales. The new glass, it should be said, is exceedingly hard.

Proceedings of the Chemical Society.

At the opening of the meeting of the current season, Professor Church gave an account of his chemical researches on some Cornish minerals. Among these he found three which had not been previously described:—1, a hydrated phosphate of cerium; 2, a hydrated phosphate of calcium and aluminium; and 3, a hydrated arseniate of copper and lead. The last of these the author proposes to call Bayldonite. For the first the name Churchite has been proposed by Mr. Greville Williams, who by optical tests discovered the presence of didymium in the same mineral.

At the same meeting a paper "On Caprylic and Oenanthylic Alcohols," by Mr. E. T. Chapman, and one "On the Absorption of Vapours by Charcoal," by Mr. Hunter, were read. The experiments of the latter author confirm those of Dr. Stenhouse, who found that the denser forms of vegetable charcoal possessed the greatest absorptive power. Mr. Hunter stated that the charcoal

* 'Comptes Rendus,' Nov. 13, 1865. † 'Comptes Rendus,' Nov. 6, 1865.

prepared from cocoa-nut shell condensed the largest amount of the various vapours he experimented with. These included the vapours of water, bisulphide of carbon, common alcohol, methylic and amylic alcohols, benzol, ether, and chloroform, and of these the vapour of methylic alcohol was most freely absorbed. It was remarked that the absorption of vapours by charcoal is always terminated in a much shorter time than in the case of permanent gases.

At the next meeting (Nov. 16), a paper "On Nitro-compounds, with remarks on Isomerism," by Dr. Mills, was read. The paper gave an account of the author's examination of the *alpha* and *beta* varieties of nitrobenzoic acid, with especial reference to the action of hydriodic acid upon them, the difference in their behaviour to this agent being considered to indicate a difference between the nitryl radicals they contain. The author also pointed out a difference in the behaviours of naturally formed benzoic acid, that obtained from gum-benzoin, and the acid procured artificially, the former being nitrated with considerable difficulty, the latter with comparative ease. A mononitrated compound is ordinarily obtained with the natural acid, while the artificial yields a dinitro-compound. But on raising the energy of the attack by employing a mixture of nitric and sulphuric acids, the author obtained with ordinary benzoic acid a dinitro-compound, possessing characters nearly identical with those of the product formed by the action of nitric acid on toluol. In his remarks on isomerism, Dr. Mills controverted the view that isomeric substances are produced by variations in the position of some radical or radicals in the molecule, and expressed an opinion that the energy of the chemical reaction at the moment of the transfer of the nitryl radical conferred upon it specific functions, and thus accounted for the differences observed in the isomers.

V. ENTOMOLOGY.

(*Including the Proceedings of the Entomological Society.*)

The attention of the Entomological Society was, at its October meeting, directed by Dr. Wallace, of Colchester, to the cultivation of the Ailanthus silk-worm (*Bombyx cynthia*), and to the probability of its becoming a lucrative occupation in this country. *Ailanthus glandulosus*, the food-plant of the insect, is a tree of remarkably quick growth even on the poorest soil, and the insects require no protection whatever, except from the birds. This year, from 18,000 eggs, he had obtained 5,000 cocoons. He had not yet attempted to wind the silk, but if this could be readily effected, he could see no difficulty to its successful cultivation, as all the necessary operations could be performed by children. "Ailantine" silk is now being introduced largely by the French merchants direct from China, notwithstanding that its culture is rapidly advancing in France.

Among the rich collections made by Mr. Wallace in the Malayan archipelago, the Buprestidæ, one of the most gorgeously coloured families of beetles, were not the least important. Mr. Wallace's set having gone to Paris, has been worked out and described by M. Henri Deyrolle in a beautifully illustrated volume. The number of species in the collection amounted to 355. Some years ago they were considered a numerous family, "200 species being known." By the way, we may mention that Australia has furnished, it is calculated, about 600 species to our cabinets, nearly all differing generically from those of the Malayan region.

To the list of insects serving as food for man we must now add the "Kungo," mentioned by Dr. Livingstone and his brother in their new work on the Zambesi. The kungo is a "minute midge" filling the air in countless millions, and "looking like smoke rising from miles of burning grass." These flies are gathered at night by the natives, who boil them into cakes, "about an inch thick and as large as the blue bonnet of a Scotch ploughman;" they "tasted not unlike caviare, or salted locusts."

The Rev. G. T. Browne, who has recently published a very interesting work on the ice-caves of Switzerland, lately sent to Mr. McLachlan, who brought them before the Entomological Society, some insects which he had found in one of those caves. Mr. Browne says:—"There was no communication with the outer air. These flies were found at a very considerable depth in the earth, down a rock-fissure, a good hundred feet below our point of entrance, which was in itself low down in a face of rock. At the bottom of this we came to a chamber, one corner of which was shut up by a curtain of ice—hermetically sealed up. We hewed a hole through it—all was utterly dark—and found only ice within. . . . The ice-roof of the ice-trough was thickly studded with these flies, standing still, but running swiftly when disturbed. I caught two, lying flat on my back and lowered by a rope. The other two were found on my dress and beard when I was dragged up again." These were caddis-flies, a species of *Stenophylax* (Trichoptera). One was a large *Paniscus* (Ichneumonidæ), apparently the only one found. It was suggested that the caddis-flies, or rather their larvæ, might have worked their way up from some underground stream, of which there were indications, but this idea will not explain the presence of the ichneumon-fly.

The new part of the Linnean Society's Transactions contains a paper by Mr. Bates, on the Phasmidæ, a most grotesque family of Orthoptera, some of them twelve inches long, and imitating sticks, patches of lichen, and living and dead leaves. Respecting the excessive variability of this family Mr. Bates says, "The difficulty which we find in defining generic groups in the family is explicable on the grounds that when there is much of this adaptive modification, all the corporeal parts concerned must have become to a high degree variable." The division of the family according to the absence of wings, or their presence in one or both sexes, appears to be highly artificial. There are now 540 species described.

Entomological Society.

At the September meeting, Mr. McLachlan exhibited three insects new to Britain—*Sialis fuliginosa*, Pictet (Neuroptera), *Stenophylax infumatus*, McLach, and *Rhyacophila ferruginea*, Hagen? (both Trichoptera). Prof. Westwood gave the Society an account of the Exhibition of Economic Entomology which was opened in Paris on the 15th of August last. Among the more interesting subjects were a great variety of bee-hives of novel construction, some of which could be sold for 1 fr. 25 c., and a large collection of silks contributed by M. Guerin-Méneville. Mr. Stevens exhibited a collection of Coleoptera from Damara-land made by Mr. Andersson.

October.—Some insects taken by the Rev. G. F. Browne, in an ice-cave in Switzerland, were exhibited by Mr. McLachlan. Dr. Wallace exhibited the various stages and entered into copious explanations respecting the Ailanthus silk-worm (Bombyx cynthia), its life-history and culture. Mr. Scudder (Secretary of the Boston (U.S.) Natural History Society) exhibited a gigantic fossil species of *Ephemera* from the Devonian Rocks of New Brunswick. He also gave a short account of Mr. Truvelot's attempts to cultivate at Philadelphia the *Bombyx Polyphemus*, another silk-producing moth. Mr. S. S. Saunders (Consul-General at the Ionian Islands) exhibited numerous specimens in spirits of the Strepsipterous genera *Xenos* and *Hylecthrus* in all their stages. A continuation of Mr. Wilson's paper on the South Australian Buprestidæ was read. A paper was also read by Mr. McLachlan on "New, or little known, Genera and Species of Trichoptera from Asia, Australia, New Zealand, and the Malayan Archipelago."

November.—A new moth taken at Manchester was exhibited by Mr. Bond; it has been named *Acidalia mancuniata* (!) by Dr. Knaggs. Some remarkable photographs of various minute parasites by Dr. Maddox were also exhibited. The following Coleoptera new to Britain were exhibited:—*Myrmedonia plicata*, Er., taken at Bournemouth, *Ægialia rufa*, Fab., *Lithocharis castanea*, Grav., and *Monotoma 4-foveolata*, Aubé. The papers read were: by the President, "On *Calamobius* and *Hippopsis*;" by the Rev. Douglas Timins, "On the Localities of European Lepidoptera;" by Captain J. Mitchell, "Remarks on Captain Hutton's paper on the Silk-worm;" by Mr. G. J. Bowles, "On the Occurrence of *Pieris Rapæ* in Canada;" by Mr. W. C. Hewitson, "On a variety of *Chrysophanus virgaureæ*, from Zermatt;" and by the same author, "Descriptions of New Hesperidæ;" by Mr. J. S. Baly, "New Genera and Species of Gallerucidæ;" and by Mr. D. Sharp, "A Monograph of the British Species of *Agathidium*." This paper contains descriptions of three new species.

VI. GEOGRAPHY.

(*Including the Proceedings of the Royal Geographical Society.*)

The geographical intelligence since our last chronicle has been small in amount. An account of Mr. Baker's discoveries will be found in a paper read before the Geographical Society. It is strange that each of the new discoveries tends to confirm the general accuracy of the old Arabian geographer of the Middle Ages, who made the Nile rise from vast lakes in the centre of Africa. Above 500 sketches in oils and water-colours by Mr. Baines, whose book we noticed before, bring before us vividly the peculiarities of African scenery, especially the part about the Victoria Falls of the Zambesi. The latter are remarkable, inasmuch as the river disappears through a cleft from which it emerges to descend again. The spray ascends to a height of 1,200 feet, and by its subsequent fall it waters the country round for some distance.

The work of Mr. Palgrave on Central Arabia is not the mere narrative of an acute and accurate traveller, it is the experience of a man whose whole heart was in his work, who had had an excellent training, who had read all that was known about the land he visited, and was thoroughly and perfectly acquainted with the language and the religion of the country he visited. Even without the knowledge acquired by traversing a land where still the Arabic of the Koran, a grammatical and nervous language, not the weak colloquial dialect of Egypt and Syria, is spoken, the dissertations on many points of the Mahommedan religion would have become standard references. The doctrine and practices of the Wahabees throw much light on the Koran and on the position that the Mahommedan religion may be expected to hold: a subject of much importance at a time when the African missions are being discussed by bodies of men from a purely external point of view, utterly unconnected with religion.

Captain Wilson, R.E., has succeeded in obtaining the true level of the Dead Sea. Previous observers had made it 710 feet above, 710 feet below, on a level with, and at all kinds of depths below the Mediterranean. Captain Wilson, from the work of two independent observers with separate instruments, assigns 1,292 feet as the depression on the 12th of March, 1865, a line of drift wood marking 2·5 feet above this as the level at some period of the year, and the testimony of Europeans and Bedouins unite in testifying that the sea sinks at least six feet in the summer. The greatest depression therefore would be 1,298 feet below the Mediterranean, and when the sea is highest the difference would only be 1,289·5 feet.

The success of this preparatory expedition to Palestine has led to the formation of a Society which represents opinions of all kinds on religious matters, and a great variety of speculation on scientific points, for the purpose of extending this survey and carrying out to a far greater extent the systematic exploration of many points of interest in the Holy Land. All the natural sciences are to receive due attention, and archæology is to be assisted, as it has never been previously, by well-arranged and systematic excavations. Certainly in the present day it would be well that we should do somewhat towards illustrating the course of Jewish history, by an appeal to Jewish antiquities and topography, and by a thorough sifting of the geological, zoological, and botanical peculiarities of the Holy Land. What has already been done in Assyria and Egypt will in more than one way be advantageous for this work. Experience in the great work of exploration has been gained, and that from the very nations who most of all influenced the politics and the art of the Jews. We now see that the politics of the Israelites were influenced at one time by Egypt, at another time by Assyria or Babylonia. If therefore we find at Nineveh and Thebes undoubted traces of Jewish doings, how much more light may we not expect to have thrown upon explorations in Palestine, by our previous knowledge of Egyptian and Assyrian inscriptions, antiquities, and architecture?

As a kind of precursor to this more full and systematic research, Mr. Tristram has published a work which shows the amount of light that one man in a short period can throw upon a subject touched upon, indeed, by hundreds in all ages, but never scientifically exhausted. Mr. Tristram spent about eight months in various parts of the country, and was assisted by a young botanist, a zoologist, one or two sketchers, and a photographer, so that much of his information has a freshness not often observable in travellers over a well-known region. Mr. Tristram spent a considerable time in the neighbourhood of the Dead Sea. He nearly exhausts this subject. Contrary to our usual notion of this lake Mr. Tristram describes the neighbourhood as very thickly populated both by beasts and birds of great variety; the sea itself, however, is "dead," inasmuch as it contains not a living thing, fish or mollusk, and even those living in the salt pools near the shore would not survive when placed in the water of the sea. The geological peculiarities of the valley do not escape this traveller.

He would throw the volcanic action back far beyond the time of the destruction of the cities of the Plain, of the cause of this latter commotion he finds no explanation.

The Russians and Americans are pushing forward the telegraph from California across Behring's Straits to the mouth of the Amoor. It is possible that the quickest route of communication with the Western continent may be through Siberia.

In Switzerland the Aiguille Verte and the Matterhorn have both been surmounted by Mr. Whymper, the Gabelhorn by Mr. Moore, and other untrodden parts by various members of the Alpine Club, which has also done good service in assisting and bringing forward Mr. Ball's 'Guides,' with descriptions of each col and pass from the actual observation of its various members.

Besides the death so much to be lamented of climbers of this Club, we have to record the loss of Mr. Rae, a companion of Dr. Livingstone; Dr. Daniel also, an African traveller, and a medical and botanical writer.

Since 1849 nothing has been heard of the unfortunate Australian traveller Leichhardt, and his fate is somewhat doubtful. One tribe of aborigines industriously promulgated an account of his death. The locality where this is supposed to have taken place has long since been assigned to squatters, but no remains of men or cattle have ever been discovered. It is therefore thought to be possible that some members of the expedition might have been made prisoners by the natives, who, to prevent discovery, spread this report of their death. Once captured, there was but slight hope of ever escaping again, and therefore it is conjectured that some of the party might still be living in servitude. Several persons, travellers or escaped convicts, have lived amongst these tribes for a greater period than that which has elapsed since 1849; consequently the ladies of the colony of Victoria have fitted out an expedition to make a search for the remains of this unfortunate party. They applied to the female crowned heads of Europe to assist them in this romantic if not very hopeful search; the Government of Queensland have subscribed 1,000*l.* towards this object, and the other Governments of Australia have given smaller sums. If the direct object of the expedition fail, we cannot but hope that it may add somewhat to our scanty knowledge of the interior of the continent.

Proceedings of the Royal Geographical Society.

At the last meeting of the Society before the close of the session of 1864–65, a paper was read, describing Lieutenant-Colonel Lewis Pelly's visit to the Wahabee capital of Central Arabia. This paper has especial interest, since the accounts of Mr. Giffard Palgrave first excited curiosity about this country. The visit of Colonel Pelly comes to supplement the jottings that the disguise of a Syriac physician alone permitted to Mr. Palgrave; in fact, one of the reasons assigned for the journey was that direct observations had not been made, and consequently the position of the cities in the interior had not been accurately determined. Official duty conveniently coincided with the desire of geographical information, and accordingly with two officers of the Government civil establishment on the Persian Gulf, Dr. Colville and Lieutenant Dawes, Colonel Pelly started for the interior on the 18th of February in last year. From Kowait, in the north-western corner of the Gulf, they travelled on camels over the desert in a direction S.S.W., journeying from a little before daybreak to sunset, when their tents were pitched with the door towards the north star, in order to enable them to make their astronomical observations during the night, when their Arab attendants were asleep. On this occasion Colonel Pelly did not, as formerly from Teheran, wear his uniform as a British officer; but whilst not concealing his nationality, he never thrust it offensively forward, wearing the ordinary dress of the country. The first part of the journey was over a country slightly undulating, inhabited only by snakes, lizards, and insects. Grass and flowers are common enough in early spring to give a slight tinge of green to the landscape. Seven ridges of hills traversed the line of their march and extended for some distance, for they were again crossed on the return by another route. It took seven days to traverse the sandy ridges and narrow valleys, a gradual ascent all the way to a plain called Ormah, over which some brushwood was sprinkled, and through which small streams flow until they are lost in the arid soil. The plain is bounded by a ridge of hills through a ravine, in which the travellers passed to another upland plain, and this kind of progress continued until they reached Riadh, the capital, in the midst of a country studded with groves of date-palms, fifteen days after their departure from Kowait. The mean of five solar observations gives this place long. 46° 41′ 48″ and lat. 24° 38′ 34″. Colonel Pelly had three interviews with the Amir, who is absolute head of his kingdom in both spiritual and temporal matters. The Amir himself placed no obstacle in the way of scientific investigation, but his attendants are extremely bigotted and intolerant, The magnificent stud of Nejid horses was opened to the inspection of the visitors, as it had been to Mr. Palgrave.

A paper on the Korea was furnished by Captain Allen Young, who described it as an almost untrodden ground for geographers, being only known from the description of Chinese and Japanese writers, but few Europeans ever having set foot on its soil. It has been invaded and encroached upon by both those peoples, and the latter still hold a part called Fouchan, immediately opposite the most western of the Japanese islands, Tsu-sima, the prince of which is on friendly terms with the potentate of the Korea, and is looked upon as the only means of approaching this despotic and reserved prince. The French sent an embassy in 1848, but it was wrecked, and the attempt was not renewed, but both they and the Russians are expected to try to gain a footing. The produce of the country consists of fine tobacco, silk, paper, furs, cotton, hemp, rice, wheat, gold, silver, and copper; specimens of which were found in Pekin during its late occupation. Since this paper was read, the official report of the consuls in China has been published, and from this it appears that by means of the Chinese port of Newchwang, at the head of the Gulf, the Koreans obtain European manufactures, especially glass, as a substitute for their oiled paper. The interchange takes place at a fair about ten miles from the Chinese town nearest the frontier, to which place the Koreans bring gold-dust, tiger-skins, and ginsing.

The session of 1865-66 began on the 13th November last, with a few general remarks from Sir R. Murchison, the President, introductory to a paper by Mr. Baker, the Patron's or Queen's medalist of last year, and the discoverer of the second great lake in east Central Africa, which furnishes the Nile with its main body of water. Mr. Baker, who is described as sufficiently like Captain Speke in appearance to be easily mistaken for his brother by some of the African tribes, stated that he had started in 1861 to discover, if possible, the sources of the Nile.

He began by tracing the tributaries that run from Abyssinia. During the following year, he continued to ascend the White Nile, and this part of the country is much as it has been often described before: desolate, swampy, and unhealthy. At length, having reached Gondokero, much to his surprise, he met Speke and Grant, and relieved their most pressing wants. From the accounts of their success, he was encouraged to press on to try and reach the Karuma Falls that they described to him. This he at last did, and thence he followed the course of the river westward until it ran into the lake, which up to the present time has been called the Luta Nzigé, but which Mr. Baker proposes to call—for what reason we are at a loss to discover—the Albert Nyanza. This lake, which was first beheld from a height of 1,500 feet above its waters, is above 260 miles long, and about 60 broad, and is surrounded in a great part of its circuit by lofty rocks, thus differing very remarkably from most of the African lakes. The principal difficulties of Mr. Baker in the latter part of his journey originated not so much from the opposition of the natives, though this was considerable, as from the mutinying of his men, who formed themselves into bands of plunderers and joined the slave-traders. The quantity of water which issues from the lake to form the Nile is still a matter for further research.

At the next meeting of the Society, held on November 27th, Mr. Richardson read an account of an overland expedition from Rockhampton, Queensland, to Cape York, under the command of Messrs. F. and A. Jardine, which was undertaken for the purpose of discovering a route whereby live stock could be taken by land from the interior Queensland pastures to supply the new settlement of Somerset, at Cape York. The party left Rockhampton on May 14th, 1864, and reached Somerset on March 11th, 1865; they traversed the country watered by the rivers Lynd and Mitchell in October and November, and report very unfavourably of that region; farther north most of their horses died, after excessive sweating, blindness, and contraction of the stomach, apparently from eating a poisonous herb; but in January, on leaving the west coast of the gulf (lat. 14° S.), and proceeding eastward, they came to a good pastoral country, crossed several creeks, and, on the 24th of that month, discovered a new river, which they named the Jardine, flowing westward into the gulf.

Mr. Dalrymple next read a paper, "On the Establishment of a New Settlement, Cardwell, in Rockingham Bay, and on the Discovery of a Route over the Coast-range to the Valley of Lagoons," in which he described the position and physical features of the new settlement and its neighbourhood, and narrated the successful crossing of the coast-range, the discovery of a new river, which he named the Herbert, and the making of a road fit for wheeled vehicles over the pass. This road connects all the interior country, and the banks of the Flinders, Lynd, and Burdekin, with the shores of the Pacific, and is 96 miles in length.

A third paper was then read by Mr. J. P. Stow, entitled "A Boat-voyage from Adam Bay, North Australia, to Champion Bay, Western Australia." The author had been one of a large party of colonists who attempted to establish a settlement at the mouth of the Adelaide, in Adam Bay, Northern Australia; the endeavour failed completely, and the colonists quitted the isolated spot in small numbers, as opportunity offered. Mr. Stow and six others put to sea in a small boat 23½ feet long, and coasted round the northern and western shores of the continent, in the hope of reaching the settlements of Western Australia, at any rate, the new settlement in Camden Harbour, 500 miles distant. Favoured by the weather, they accomplished this first stage of their journey, and Mr. Stow graphically described the voyage, the barren nature of the intervening country, and their continued disappointment at the numerous archipelagos and islands being all equally sterile. They found a miserable state of things at Camden Harbour, the settlers being about to abandon the place, so they continued their adventurous voyage for 1,000 miles more. During this stage they met with much severe weather, including a gale of wind which lasted three days; the country continued barren until they reached Champion Bay, when it began to improve.

Previous to the reading of the papers at the third meeting of the Society this session (December 11th), Sir R. I. Murchison, President of the Society, adverted to the great loss the science of Geography had sustained by the death of the distinguished African traveller, Dr. Henry Barth.

The intelligence previously received of the disastrous termination of two African expeditions had since been to some extent contradicted, for M. du Chaillu (who is now in England) had succeeded in penetrating 200 miles farther than on his previous journey; and though an unfortunate accident had led to an encounter with the natives, he had happily saved his journals, chronometers, and records of astronomical observations. The other expedition—namely, that of the Baron von der Decken on the east coast—had certainly met with a disaster, one of the two steamers having been wrecked on the bar of the Jub; but the other and larger one had been repaired, and had conveyed the party a considerable distance up the river.

The first paper read was on "A Boat-journey along the Coast-lakes of East Madagascar," by Capt. W. Rooke, R.A. The author had heard that the chain of lakes south of Tamatave might be traversed for several hundred miles in a boat sufficiently light to be carried over the short portages, and accordingly attempted the exploration with three companions and a native crew. The journey occupied 32 days, during which the party travelled nearly 400 miles, and passed numerous villages, and several larger towns of about 1,000 inhabitants each; it was chiefly along winding channels and streams, which connected the lakes together, and whose banks were clothed with magnificent tropical vegetation, arching overhead in the narrow watercourses, and thus adding greatly to the beauty of the scenery.

Another paper, entitled "On Ankova, the Central Province of Madagascar, and on the Royal or Sacred Cities," by the Rev. W. Ellis, was then read. The provinee of Ankova is the most important of the twenty-two into which the island is divided, from being the country of the Hovas or dominant race; it is 150 miles in length by nearly 100 in breadth, is hilly or mountainous, the elevations rising singly or in masses, rather than forming continuous chains. Mount Ankaratra, in the south-west of Ankova, is one of the highest mountains in the island, being about 13,000 feet above the level of the sea. The author described the streams, lakes, forests, and fertile valleys between the isolated mountains, and concluded with a notice of the twelve sacred cities of Ankova, which derive their sanctity from having been the birth-places, abodes, or burial-places of their monarchs. Europeans are forbidden to enter them, and although some of them are places of large size, they have not yet been laid down on our maps. The belief in the influence of the spirits of their deceased monarchs is one of the chief features of their religion, and is stated by Mr. Ellis to enter into all their most important ceremonies, and to influence the actions and policy of royalty.

VII. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

One of the most important contributions to British Geology that has appeared during the past quarter is a memoir by Mr. Searles V. Wood, jun., entitled : "Remarks in Explanation of the Map of the Upper Tertiaries of the Counties of Norfolk, Suffolk, Essex, Middlesex, Hertford, &c., &c., and accompanying Sections." In this paper the author further explains, and somewhat modifies, his classification of the glacial deposits in the east of England ; but as his views have already been noticed in these Chronicles (vol. i., pp. 330 and 478), we need give no introductory explanation. He now divides the Glacial deposits into Upper, Middle, and Lower Drift ; the Middle and Lower Drifts having hitherto formed his "Upper and Lower Series of the Lower Drift." A difficulty which we suggested formerly, Mr. Wood has met to some extent by calling all the more recent sands and gravels Post-glacial, a very good name as a distinction, though not strictly true. Mr. Wood's views differ considerably from those generally accepted ; for instance, he is of opinion that the Chillesford beds (usually thought to be of Norwich Crag age, or a little newer) belong to his Middle Drift series. This Middle Drift is an important formation ; it consists chiefly of sands and gravels, and intervenes between the Boulder-clay (Upper Drift) and Boulder-till (Lower Drift), and we should not be at all surprised at its ultimately furnishing the key to a comparison of our Glacial series with that of Scotland. The differences in the deposits of the two countries are rather remarkable (compare vol. ii., pp. 679 and 680), and an explanation of them would doubtless soon lead to a well-grounded interpretation of the whole of the phenomena of the Glacial period. Perhaps the map and numerous sections are the most valuable portions of the paper.

The upper limit of the Eocene formation, the lower boundary of the Miocene, and the question whether the Oligocene of Professor Beyrich really forms a natural group of deposits, have frequently of late years formed the subject of discussion, and even of controversy. Any contribution to the facts of the case must therefore be very welcome to all who take an interest in Tertiary Geology. Accordingly we are very glad to see published the results of Professor Reuss's examination of the German Upper Oligocene Foraminifera, Bryozoa, and Corals, which have appeared in the 'Sitzungsberichte' of the Vienna Academy (vol. i.).

Of Foraminifera the beds are known to contain 142 species, of which 67 (47 per cent.) are peculiar to that horizon, 47 (33 per cent.) occur in Middle Oligocene strata, 42 (29·5 per cent.) in Miocene deposits, 23 (16 per cent.) in Pliocene beds, and 16 (11·2 per cent.) occur at the present day. The proportion of species common to the Upper Oligocene and to the Middle does not differ, therefore, very materially from that common to the former deposit and the Miocene.

Of the Corals not much can be said; only seven species that can be determined with safety are known to Professor Reuss, of which one occurs also in the Crag of Suffolk and Antwerp, and one in the Lower Oligocene beds of Latdorf, while the remaining five are peculiar to the Upper Oligocene.

The Bryozoa are, however, much more numerous, 74 species having been determined by the author; of these, 14 species are found in the Lower, and 21 in the Middle Oligocene, 18 being also known in Miocene deposits. It will thus be seen that this evidence tends to the same conclusion as that of the Foraminifera.

The Middle Oligocene fauna does not possess the same interest as the Upper in a classificatory point of view, but Professor Reuss's more recent researches on its Foraminifera, Corals, and Bryozoa have an equal intrinsic value to the pure palæontologist.

In the 'Annals and Magazine of Natural History' for September, Dr. Duncan described six new species of Corals from the South Australian Tertiary strata. They include one new genus (*Conosmilia*), which presents certain novel structural peculiarities, and which bridges over the gaps between some of the families in the accepted classification. It "possesses the twisted ribbon-shaped columella of the sub-family *Caryophyllaceæ*, the endotheca and septal margin of the *Trochosmiliaceæ*, and the irregular septal arrangement which was so common in the Corals of the Oolitic age, and which, from its octomeral type, reflected the *Rugosa* of Palæozoic times." In this coral, therefore, we have again a trace of that Jurassic facies so characteristic of the recent Australian land-fauna. Another curious feature is seen in the only known species of this genus, namely, that the bases of the septa and the costæ are not continuous, but the septa appear to correspond with the line of depression between the costæ; but what is more remarkable still is that, according to Dr. Duncan, this feature "is common in species of other genera in Australia, but is very rare indeed in any specimens from any other part of the world." The perusal of papers containing the record of such curiosities in Natural History cannot but tempt a naturalist to speculate on their probable causes. Much might be written in an endeavour to answer the question,—What are the causes of those trivial characters, having no relation to the economy of the organism, which impress on species of certain genera, or genera of certain families, a peculiar geographical or geological stamp? For instance, Why should so many Tertiary and recent corals, peculiar to Australia, have the septa and costæ alternate instead of opposite? And why should the Jurassic species of *Cidaris* (with scarcely an exception) have crenulated summits to the bosses of the tubercles, while the Carboniferous and Cretaceous species have them smooth?

A remarkably praiseworthy paper has recently been published by Mr. T. Codrington, F.G.S., in the 'Magazine of the Wiltshire Archæological and Natural History Society,' on "The Geology of the Berks and Hants Extension and Marlborough Railways." In it the author describes all the points of interest observed during their construction, in the order in which they are met with in going from Hungerford to Devizes on the one railway, and from Savernake to Marlborough on the other. This part of his paper will be extremely useful to the geologists of the neighbourhood, and, being well done, will no doubt attract attention elsewhere; but the concluding portion, containing some general observations and conclusions respecting the formation of the Vale of Pewsey, will, in these days of "atmospheric denudation" proclivities, certainly be somewhat roughly criticized. Mr. Codrington's main conclusion is, that the Vale of Pewsey was excavated to a great extent by marine denudation, at a period between the deposition of the Lower Eocene beds and that of the Boulder-clay, the valley being of the same age as the great chalk escarpment.

'The Millstone-grit, its Fossils, and the relation it bears to other Groups of Rocks,' by Fort-Major T. Austin, F.G.S., is another pamphlet of some importance, which may also be considered a local memoir, for its contents refer chiefly to the neighbourhood of Bristol. Major Austin's long-continued search has been rewarded by the discovery of numerous fossils in this generally sterile formation. Of the forty-seven species obtained the author considers all but three to be new, and two species of Crustacea are too obscure for description. Of the so-called new species the author gives bad figures and inadequate descriptions, and we feel almost positive that the majority of them are small variations from old and well-known species. While we are glad to be able to give a large amount of praise to Major Austin for his perseverance and enthusiasm, we cannot avoid pointing out these and some other serious errors in his pamphlet. One of the sections given in the last plate bears its improbability on the face of it. The occurrence of a single fact which appears in favour of a preconceived view is too often sufficient to convince him of the correctness of his theory. Major Austin's idea of a classical name is also rather astonishing; taking, we presume, as his basis the occurrence of such generic appellations as *Cytherea* and *Venus* amongst the Lamellibranchiata, he now gives to two new genera of Brachiopods the names of *Psyche* and *Anonyma!* The reproach so often cast upon scientific men, that their writings teem with bad Latin, has originated from the abundance of such barbarisms as those coined for this pamphlet, *e. g. Cytherea minutia, Tellina antiquitus, Pinna angulatus*, &c., and the following heterogeneous series of names given to species of Pecten: *planus, flabellum, symmetria, tenuistria*, and *albidus*.

The publication of the second volume of the Palæontological part of M. Barrande's 'Système Silurien du Centre de la Bohême,' is an important event in Silurian Palæontology. It contains 107 plates, comprising figures of about 200 species of Silurian Cephalopoda, belonging to the following genera: *Goniatites*, de Haan; *Nothoceras*, Barr.; *Trochoceras*, Barr. & Hall; *Nautilus*, Linn.; *Gyroceras*, Kon.; *Hercoceras*, Barr.; *Lituites*, Breyn.; *Phragmoceras*, Brod.; *Gomphoceras*, Low.; and *Ascoceras*, Barr. Unfortunately the text does not accompany the plates, but will be published shortly; there are, however, a few notes attached to the explanation of each figure. As all the species figured are considered to be new, the appearance of the descriptions of them will be anxiously looked forward to. The present portion of this great work is as good an index as its predecessor, firstly, of the wonderful richness of the Bohemian Silurian fauna; secondly, of its distinctness from the Silurian fauna of Great Britain; and, thirdly, of the perseverance and unwearied diligence of M. Barrande.

M. Vaillant has recorded, in a paper 'Sur la Constitution géologique de quelques Terrains aux environs de Suez,' published in the Bulletin of the Geological Society of France (vol. xxii. p. 227), the discovery of shells of *Ætheria Cailliaudi*, at Chaloufs el Terraba, eighteen kilomètres from Suez: a fact of some importance in regard to the ancient course of the Nile and the antiquity of the Nile Oyster. In the same paper some interesting details are given respecting the geological constitution of the neighbourhood of Suez in the direction of the Sinai chain; but, as might have been expected, the rocks whose age has been determined belong to the Eocene and Upper Cretaceous periods.

An important work has recently been published by M. Jules Martin, entitled, "Etage Rhætien, ou zone à *Avicula contorta*, &c.;" it appeared originally in the Memoirs of the Academy of Sciences of Dijon, but has also been issued as a separate volume. The author's conclusions may be summarized as follows:—

The mineralogical transition from the zone of *Avicula contorta* to the adjoining deposits is not less complete on the side of the Infralias than on that of the Keuper.

Without exception, the deposits of this horizon are conformable both to the Trias and the Lias.

The geological movements which took place during this period began in the Triassic Epoch, and continued without interruption into the Liassic.

There is observable in the fauna a very marked predominance of affinities on the side of the Lias.

The periods of rest from biological manifestations, which occurred after the deposition of the Keuper, and after that of the zone of *Avicula contorta*, render the latter group the representative of a distinct period, and give it the value of a formation.

Its lower limit is generally well defined, whereas the boundary between it and the true Lias is in different countries more or less uncertain.

The Rhætic formation has the greatest palæontological affinity with the Lias, and therefore forms the first stage of the Jurassic series.

The last three numbers of the 'Geological Magazine' have, as usual, contained some interesting articles. Mr. Henry Woodward (the Editor) gives in the September number a description and figures of fossil "Crustacean teeth," and shows how curiously they resemble, until carefully examined, the true teeth of certain Marsupials. Mr. Carruthers has a paper in the next number on a new cone from the Coal-measures, which he makes the type of a new genus—*Flemingites*. It is allied to *Lepidostrobus*, but differs in each scale of the cone supporting a double series of roundish sporangia, whereas in that genus each scale supports only one roundish sporangium. The same author has a paper in the November number on a Fossil tree-fern from the Upper Greensand. Besides containing some observations of interest respecting the determination of the fossil, this paper is rendered worthy of notice by the author's conclusion, that the five slight constrictions seen on the stem appear to indicate an alternation of climate during the year at that remote period, similar to what we now experience. Mr. Baily's paper "On the Cambrian Rocks of the British Islands," Professor Owen's notice of M. van Beneden's "Recherches sur les Squalodons," Mr. Kinahan's notes "On Pre-glacial (?) Drift in Queen's County, Ireland," and some other articles also contain points of interest. The correspondence seems to increase in bulk and value, and no doubt forms an attractive portion of the magazine to local geologists.

Proceedings of the Geological Society.

No less than twenty-three papers are contained in the last number of the 'Quarterly Journal of the Geological Society;' we must therefore be content to notice only the more important of them in the order in which they appear.

Dr. Duncan's paper on Echinodermata from the South-eastern coast of Arabia and from Bagh on the Nerbudda is unusually interesting. This palæontologist generally makes remarks worth reading and remembering in connection with the subjects of which he treats, and those contained in this memoir exhibit a more than common breadth of mind. Finding the species he has determined to indicate a Cenomanian age, he discusses the probability of the beds containing them belonging to that period, and devotes a special section of the paper to an essay on "The Impossibility of establishing a close Synchronism between the Asiatic and other Cretaceous Strata." The remarks which follow, "On the Identity, Persistence, and Variability of the Species," are equally good and very suggestive. They at least show us how much we have to learn about the life-history of those types which we call species. The conclusion, that "as the different longevities of species and also of the individuals of species are both regulated by determinate laws, so are, doubtless, the apparently inexplicable associations of persistent, variable, nascent, and moribund species," is sufficient to indicate the nature of the subject discussed. We can here do no more than call attention to the paper, which is worthy of forming an appendix to Mr. Darwin's 'Origin of Species.'

The next paper consists of a letter "On the Fossil Contents of the Genista Cave, Gibraltar," addressed by Mr. Busk and the late Dr. Falconer to General Sir J. W. Codrington, Governor of Gibraltar. The character of the extinct fauna of Gibraltar, according to the evidence yielded by this cave, is not a little peculiar; of the Mammoth, *Rhinoceros tichorhinus*, *Ursus spelæus*, *Hyæna spelæa*, and other English, French, and German forms, "not a vestige has been detected among the fossil remains of Gibraltar." The Carnivora are, however, the most significant; "the three species of *Felis* are of African affinities, and *Hyæna brunnea*, now for the first time ascertained to have existed formerly in Europe, is at the present day chiefly found near the Cape of Good Hope and Natal." The last-mentioned discovery opens out a very large question, or series of questions. How did *Hyæna brunnea* get from Africa to Europe, or from Europe to Africa? In which of these directions did the species migrate? At what period did the migration take place? Finally, how comes it that this is a *South* African species? Human remains, stone implements of the polished-stone period, broken querns, pottery, and other objects were also found in the cave, and show that, geologically speaking, its contents are of no great antiquity. The authors conclude their letter by two very good suggestions; firstly, that a local museum should be formed, to contain objects of interest found on the rock, *and nothing else;* secondly, that a geological survey of the rock should be made by a competent surveyor. We believe that Professor Ramsay, the Director of the Geological Survey of Great Britain, has undertaken the last-mentioned task, so that we may be sure of its being well done.

Dr. Falconer's posthumous paper "On the asserted Occurrence of Human Bones in the ancient fluviatile Deposits of the Nile and Ganges" has already been noticed at some length.

Mr. Whitaker's three papers on the Chalk of the Isle of Thanet, of Bucks, and of the Isle of Wight are interesting to British geologists, but the special nature of the facts described prevents our discussing them here.

Some curious facts are mentioned in Dr. Stoliczka's paper on the Cephalopoda of the South-Indian Cretaceous Rocks, which will be read with interest in connection with Dr. Duncan's paper already noticed. It is satisfactory to find that these two palæontologists, working independently and upon different classes of animals, come to the same conclusion respecting the age of the Indian Cretaceous strata. Although none of the genera of Cephalopoda from these beds, with the exception of *Ammonites*, are represented by species which exhibit any remarkable difference from European Cretaceous forms, yet of the genus named there are four species of the group *Macrocephali*, one of the *Planulati*, and one of the *Fimbriati*, which are of course allied to Jurassic forms. "The most striking and abnormal among the Ammonites, however, are three species of the Triassic group *Globosi*," and Dr. Stoliczka may well have been astonished at their occurrence in such company.

A great deal has lately been said for and against the theory of the atmospheric erosion of river-valleys, of the Valley of the Weald, &c.; and we now have, in Messrs. Foster and Topley's paper "On the Superficial Deposits of the Valley of the Medway, with remarks on the Denudation of the Weald," a carefully prepared account of certain phenomena which are thought by the authors to prove, or at any rate to render it probable, that the Valley of the Weald owes its present surface-configuration chiefly to atmospheric causes. There are those who theorize and speculate without a knowledge of the phenomena they wish to explain; there are again those brilliant-minded and experienced men who can propound a probable theory and support it with ability, off-hand, simply from their great knowledge of natural phenomena in various districts; but there are also those equally useful workers in science, who, like these authors, accepting a theory already rendered probable, take a particular district and find out how every individual fact lends additional probability to the view they accept. Of course, in this instance, the conclusion is foregone, but we honestly believe that had the facts proved adverse they would not have been distorted to harmonize with it. Messrs. Foster and Topley show that an old river-gravel of the Medway occurs 300 feet above the present level of the river; therefore the valley below must have been excavated by sub-aërial causes—"rain and rivers." They also go farther, and say that in this case "there can be but little difficulty in supposing the present form of the ground in the Weald to have been produced entirely by these agents;" this is not yet proven, but is to a great extent highly probable. According to the chronological statement given by the authors, Col. Greenwood was the first to maintain (in 1857) that the valleys were wholly formed by "rain and rivers;" unfortunately, however, his book was but little read by geologists at the time. The question was raised *as* a question by Mr. Jukes in 1862; but Professor Ramsay has been its great exponent and advocate, and has disposed of most of the objections to his theory that have been advanced by the advocates of marine-denudation. It must not be supposed, however, that rain and rivers are considered by him and his followers to have done all the work; the sea began, and atmospheric agencies completed it.

Two out of Mr. Henry Woodward's three papers on new fossil Crustacea are well worth notice. In one the author proves that Professor de Koninck's *Chiton Wrightianus* is not a Chiton, but a Cirripede. This fossil was found in the Wenlock limestone and shale of Dudley; it is apparently allied to *Loricula* and other pedunculated Cirripedes, and thus carries back the first appearance of the group from the Lias to the Upper Silurian.

In another paper, Mr. Woodward describes a new genus of Eurypterida, which he names *Hemiaspis*. It is remarkable on account of its appearing "to offer just the link we needed to connect the Xiphosura with the Eurypterida." The author also remarks, that "there are several peculiarities about *Hemiaspis* which seem to offer analogies with the Trilobites." In this chronicle we have thus recorded the discovery of two transition-forms—a Coral and a Crustacean, and we feel confident that the determination of such links between heretofore distinct families is destined some day to form an important element in the solution of the laws which have regulated the origin and succession of life on the globe.

VIII. MINING AND METALLURGY.

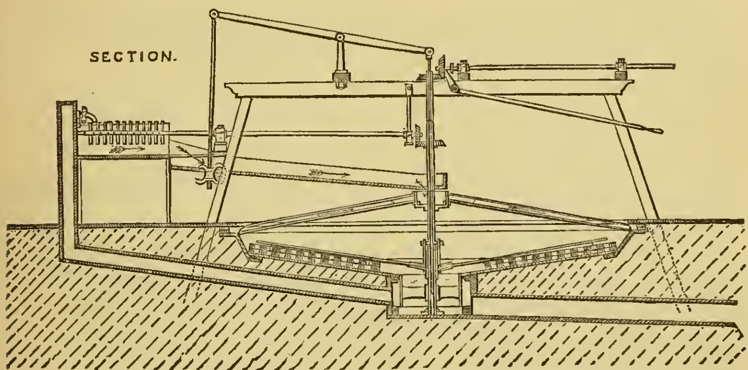
For some time past the price of Tin ore, or as it is technically termed, Black Tin, has been so exceedingly low, that throughout the tin-producing districts of the West of England during 1865 not more than six mines have been in a position to pay dividends to the adventurers. This has arisen from three causes: the failure of the American market—the large importation of tin from the Eastern Archipelago—and from the British mines forcing considerable quantities of tin upon the market, they being unable otherwise to meet the current expenses of the mines. This state of things has naturally led to a careful examination of the methods of preparing the ores for sale, with a view to the introduction of more economical methods. It is not generally known that the process of separating tin ore (oxide of tin) from the stone in which it is found is one of considerable delicacy. The quantity of tin ore is small compared with the valueless matter with which it is mixed. This will be evident from the following statement of the quantities of tin ore contained in the mass, as it is brought to the surface, from the mines named:—

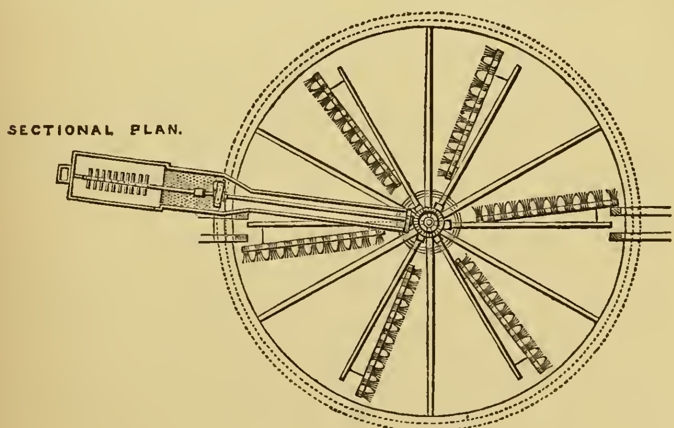
Huel Kitty, St. Agnes . . .	84	pounds of oxide of tin in every ton.		
Dolcoath, Camborne . . .	56	,,	,,	,,
Tincroft ditto . . .	35	,,	,,	,,
North Roskear, ditto . . .	25	,,	,,	,,
Huel Uny, ditto . . .	23	,,	,,	,,
East Carn Brea, ditto . . .	18	,,	,,	,,
Polberro Consols, St. Agnes .	14	,,	,,	,,
Huel Coates, ditto .	6	,,	,,	,,
Lanivet	4	,,	,,	,,

The hard quartzose contents of a mineral vein are brought to the surface from great depths, and the first operation is to reduce it to a state of fine powder, which is suspended in water. This is brought about by the continued action of heavy stamps, and the mud thus produced is made to pass through the "stamps grate" (a perforated plate of copper). This muddy fluid has usually been allowed to flow through long narrow troughs—commonly called "strips"—and when these were filled they were emptied by hand; the upper part of the strip containing the portion which was richest in tin, the lower portion being very poor. Dividing the contents of this trough and removing it to other machines, either "frames" or "buddles," was a tedious and, consequently, a costly operation.

Necessity has compelled the miner to reduce this cost as much as possible. This has been very successfully done by the use of the "round buddle," which is a circular table, or trough, slightly inclined from the centre to the circumference. The thick mud flows in at the centre, over the table, and runs off at the edges. By regulating the flow of water, and producing a slight degree of agitation by means of light brushes, which are made to sweep the surface, all the heavy matter, of course containing the tin, is deposited nearest the centre. Beyond twelve or eighteen inches from which but little tin is found.

Another form of machine has also been recently introduced, which is known as "Borlase's Buddle," being named after the inventor. This "buddle" differs from the ordinary form in delivering the fluid containing the earthy matter and the tin at the circumference, and distributing it towards the centre. The construction of this apparatus will be seen, at once, from the accompanying drawings:—





By this arrangement the tin stuff in its state of fine powder in suspension in water is, at once, spread out in a thin sheet, and the heavy matter, tin ore, is disentangled from the earthy mixture; the lighter portion flowing towards the middle of the buddle, is gradually brought under the influence of an increasing flow of water and carried away. Of course in this " buddle " all the rich portion is found around the edges of the trough. It is stated that a saving of from 30 to 40 per cent. is effected by the use of Borlase's machine.

In a " Tin stream " at Mudian Vean, in St. Martin's, to the south of the Helford river, in Cornwall, there has been recently found associated with tin and titaniferous iron (Menachanite) some small pieces of gold.

A remarkable discovery of Silver ores has been made in California. It is of so startling a character that English capitalists have sent out competent persons to investigate all the conditions. Silver Peak is situated east of San Francisco, on the eastern side of the Sierra Nevada, and nearly one degree south of the city of Austin. From an American journal we obtain information from which we make our abstract.* Silver Peak is an old extinct crater 5,000 feet above the sea level; near it is an extensive deposit of salt, and not far distant a large accumulation of sulphur. At first the searchers after the precious metals confined themselves to the Pacific side of the Sierra Nevada, but discoveries in New Mexico, Arizona, and Virginia city induced a thorough examination of the east side of that range. This proved a great success, and much wealth was obtained in the neighbourhood of Austin, a city which has sprung up within three years and which is now said to contain a population of 10,000 people. Twelve exceedingly rich lodes or " ledges," as the Californian miners call them, have been found near Castle Mount. The specimens brought to New York by Colonel Catherwood are remarkable for their richness. " If there is no mistake," says the 'Journal of Commerce,' " a new deposit, superior even to the Comstock lode, which has furnished so many millions of silver, is about to pour into our market its limitless supply of this precious metal." We shall watch the result with much interest.

Mr. A. Blatchley, mining engineer of Austin, has made a rather extensive report on the whole of that district, of which the Reese river is the centre. He informs us that all the useful metals, as gold, silver, copper, lead, antimony, mercury, arsenic, manganese, and iron, are found in abundance, and tin in small quantities.

Only five years have elapsed since the first silver was worked in this district, and last year the amount shipped from Nevada nearly equalled the amount produced in Mexico, and the production of this year will, it is said, nearly double that of last. The value of the

* 'New York Journal of Commerce.'

average yield of all the ore worked in the mines of Austin is $144 per ton. Nearly every variety of silver ore known to the mineralogist is found in the vicinity of Reese river. Native silver is found as wire silver, and in thin lamina between different layers of ore, also in masses of irregular shape mixed with the ore. This latter variety is mostly found in the Revenue Mine, on Lander Hill, where pieces weighing five pounds have been found; it is also discovered in minute particles in the oxide of iron, forming the ore known in Mexico as *Colorados*. Above the water level the ores of silver are Chlorides, Iodides, Bromides, and Selenides; below the water level they are generally Sulphurets.

The annual production of Coal, in the coal producing provinces of the Chinese empire, has been given by Mr. Mossman as follows:—

	Tons.
Che-Kiang	80,000
Kiang-See	190,000
Hoonan	260,000
Quang-tung	130,000
Northern Provinces	340,000

The value of this coal at the pit's mouth is given, in round numbers, as 1,200,000*l*., and we learn from the same authority that the consumption of native coal in China is only one ton to every 406 persons.*

Coal is being worked by the sanction of the Viceroy of Egypt in the neighbourhood of the classic mountain Olympus. Depôts are about to be formed on the shores of the Red Sea to supply the steamers with this fuel, which is said to be of good quality, and can, it appears, be sold much cheaper than any other coal.†

Metallurgy.

At a recent meeting of the Institute of Civil Engineers of France, M. Gaudry read a paper on a new French puddling machine which has been regularly at work at the Clos-Mortier Iron Works, near St. Dizier, for four years. By this machine the ordinary puddler's "rabble" is worked regularly over the furnace door, and the tool is changed with the greatest readiness as often as this is needed. The puddler has only to watch the operation, without anything to tire him, until the time comes for him to "ball" the iron, the machine being then thrown out of action. The apparatus is placed either on the top of the furnace, or in a pit underneath, or alongside. It consists of a suspended connecting rod, which is capable of vibrating in all directions for working the rabble, and is itself worked by an arrangement of rods, shafts, and cranks supported on the brickwork. The motion is generally obtained from

* From a letter to Mr. T. Y. Hall, of Newcastle-on-Tyne, from Mr. Mossman, communicated to the Birmingham Meeting of Mining Engineers.

† 'Les Mondes,' 5th October, 1865.

a driving power common to all the furnaces, by means of an intermediate shaft with pulley and strap; and at each furnace the strap is provided with a tightening lever, which is lowered or raised for starting or stopping the apparatus. By this means the rabble receives a rectilinear movement backwards and forwards across the furnace, and, at the same time, a much slower travelling motion from right to left and *vice versâ*—in the direction of the length of the furnace doors. In consequence of this double movement the rabble works over the entire furnace floor, and effects a uniform and complete stirring of the metal, with a rapidity and regularity of which few puddlers are capable.

It is well known that a peculiar ferruginous sand is found on the coast of Taranaki, not far from Whanganni, in New Zealand. Attention has been from time to time called to this sand, which appears by analysis to consist of—

Protoxide of Iron	88·45
Oxide of Titanium and Silica . . .	11·43

Numerous difficulties attendant on smelting this ore have hitherto prevented its being employed in the manufacture of iron. It is, however, now stated that Mr. Charles Martin, C. E. of London, has successfully produced good pig-iron from the Taranaki sand by smelting it in small furnaces with coke for fuel. The examples of iron and of steel manufactured from it which have been exhibited are of a very high character, which is supposed to be mainly due to the presence of Titanium.

Amongst the most remarkable illustrations of the powers of modern Metallurgy may be noticed the fact, that on the 17th October Messrs. Bessemer and Sons, at East Greenwich, cast a cubic block of steel of the enormous weight of 100 tons. Large as this block is, it was far exceeded by what has been done at Bolton by the aid of Messrs. Ireland and Sons' patent upper twyer cupola furnace, where a block of steel weighing 250 tons was cast. This furnace melts at the rate of thirteen tons of Bessemer steel in an hour, and is charged with three hundredweight of coke to fifty hundredweight of metal. The saving of fuel is one of the advantages of these furnaces, of which there are ten at Woolwich Arsenal, effecting an economy of coke to the extent of 2,000*l.* a year. The large block of steel cast at Woolwich and another somewhat smaller are to serve as anvils for steam hammers in the works of the Messrs. Bessemer, which are now approaching completion.

'Guide Pratique des Alliages Métalliques,' by M. Guettier, Engineer and Director of Foundries, and author of 'La Fonderie en France,' has just been published at Paris. This work treats the question of alloys with much care.

M. de Cizancourt, in a paper addressed to the Academy of Sciences, puts forth a new theory of Iron and Steel. Oxides of iron have usually been considered as degrees of oxidation of the same metal; M. Cizancourt adopts a view put forward in the first instance by Berzelius, that there are two sorts of "Iron-metal," to which he respectively gave the names of *ferricum* and *ferrosum*; these are supposed to represent two allotropic states of iron. Ferrosum is the metal extracted from the protoxide of iron through the reducing agency of hydrogen; the nearest approach to this is commercial iron, being what is called "bright iron." The iron derived from the anhydrous peroxide is the metal called ferricum. The common sorts of foundry iron are supposed to be this metal with some carbon. The author says that certain kinds of cast-iron identical in their chemical composition, appear so different from each other, and give such opposite results in working them, as to compel us to distinguish them in practice. In metallurgy, M. de Cizancourt contends, the various sorts of iron are a matter of mere secondary importance; the real characteristic to be taken into account being, the degree of oxidation of the ore, from which they have been extracted. Malleable iron is supposed to be formed of mixtures in variable quantities of the two kinds of iron which pass into the state of "ferricum." Steel is also supposed, according to M. Cizancourt's view, to be a reunion of the two conditions of iron; the metal being the more perfect the nearer the two irons unite in the proportions in which they exist in the mineral state.

Mineralogy.

For some time past attention has been directed to a remarkable phosphatic mineral, discovered near Cwmgynen, about sixteen miles from Oswestry.

It occurs as a nearly perpendicular vein in a dark bituminous limestone. The following analyses of this mineral have been published by Dr. T. L. Phipson*:—Nos. 1 and 2 were solid specimens, weighing several pounds, taken from different localities; No. 3 was a powdered specimen from another part of the mine; while No. 4 is a mean analysis of three other district specimens.

	I.	II.	III.	IV.
Water	8·00	3·00	6·00	5·00
Phosphate of Iron	29 40	19·00	27 00	14·60
Phosphate of Lime	13·00	50 00	—	—
Lime	—	—	21 91	17·43
Silicate of Alumina	44·00	26·00	22 02	38·60
Protoxide of Iron	—	—	20·88	9·87
Carbonates of Iron, Lime, &c.	5·60	2·00	2·19	14·15
	100·00	100·00	100·00	100·00

This mineral is evidently a compound of phosphoric acid with

* See 'Reader,' October 21, 1865. See 'Chemical News' also.

iron and lime in variable proportions, the one substituting the other in a very uncertain manner. The composition of the mineral cannot indeed be determined until more exact analyses shall have been made.

The discovery of a mineral resembling the celebrated Bog Head coal in New South Wales, and the manufacture of paraffine oil from it, is now exciting much attention in the Australian colonies.

A colonial paper* states that this mineral is found near Hartley, and also near Wollongong. The seam near Hartley is five-and-a-half feet in thickness, and is worked through a tunnel. This mineral is of a dark-brownish colour; it is very tough, so that if struck with a hammer the implement will bound off as it would from a block of wood; it has a conchoidal fracture, and does not powder when broken. This Hartley mineral is stated to be superior to the Bog Head coal, in consequence of its yielding a larger quantity of gas, and therefore of oil, and also of its freeness from sulphur. The importation of paraffine oil into Australia is large, and it is confidently believed that the oil can now be produced at a lower price in the colony than it can be imported from America.

"On the Growth of Flos Ferri, or Corolloidal Arragonite," is the title of a paper by Mr. W. Wallace, of the Silver Band and Dufton Mines, well known by his work on 'Metalliferous Deposits of Alston Moor,' which was read before the Geological Society of London, and is published in the November number of their journal.†

It is not possible to condense Mr. Wallace's views. It may be briefly stated that he considers the growth of arragonite to be from within and not from without as has been usually thought. "Arragonite growing in an atmosphere may be considered a type of vegetation, the forms of which it more especially mimics."

Dr. Gustav Tschermak has published "Chemico-Mineralogical Researches on the Felspars." ‡ The author believes that with the exception of Hyalophane and Dauburite, all the Felspars may be resolved into mixtures of three true species or *genera* as he terms them, namely, those known in the pure state as Adularia, Albite, and Anorthite, Soda, and Lime Felspars. The potash Felspars he considers to be the result of regular alternations of Orthoclase with Albite; and the other Felspars to be isomorphous mixtures of Albite with Anorthite, sometimes with small quantities of Orthoclase. Oligoclase; Andesine, and Labradorite appear to be merely members of a great series in which many transition forms occur.§

* 'Sydney Herald and Sydney Mail.'
† 'Quarterly Journal of the Geological Society,' No. 84, p 413.
‡ 'Chemisch-Mineralogische Studien.' Von Dr. Gustav Tschermak.
§ 'The Journal of the Chemical Society,' October, 1865.

Professor Church has recently brought before the Chemical Society a communication, entitled "Chemical Researches on some New and Rare Cornish Minerals." Hydrated Cerous Phosphate is a new mineral found by Mr. Talling, of Lostwithiel, some time ago. It occurs in a copper lode on quartz and killas. The general lustre of the mineral is vitreous; but the conspicuousness of the end-faces with a brilliant pearly lustre causes the general aspect of the grouped crystals to be splendent. The crystals are doubly refractive, but no specimen has yet been obtained capable of affording indications as to the number and direction of the optic axes. For the same reason they have not yet been examined as to the presence or absence of pleochroism. The colour of the mineral is a pale smoky grey, with a faint tinge of flesh red; the streak and powder are white. The hardness of the mineral slightly exceeds 3; it distinctly abrades a cleavage surface of calcite. The density has not been determined with accuracy, but it is about 3·14.

Professor Church's analyses give the following as the mean percentages:—

$Ce''O$	51·87
$Ca''O$	5·42
P_2O_5	28·48
H_2O	14·93
	100·70

As Professor Church says, "The occurrence of a British mineral rich in Cerium is, of course, of considerable interest, but the complete novelty of the species, as a *hydrated* phosphate of the metal, attracts particular attention, the known phosphates, cryptolite, monazite, &c., being when quite unaltered and pure completely anhydrous."

Mr. Talling supplied Professor Church with a mass of quartz crystals mixed with iron and copper Pyrites, partly covered with Childrenite, and containing, moreover, in numerous cavities and fissures a light and soft white powder. This powder was found to contain lime, alumina, phosphoric acid, and water, together with a trace of iron. The experimental percentages obtained by analysis were:—

$Ca''O$	36·27
Al'''_2O_3	22·40
P_2O_5	30·36
H_2O	12·00
	101·03

The only known mineral phosphate resembling the present is one examined by Damour in 1853, and believed by him to be a hydrous phosphate of alumina and lime. Damour's phosphate was found in the Diamond Sands of Bahia. The present mineral was obtained from near Tavistock, Devonshire.

"*Bayldonite*" is the name proposed by Professor Church for a new

Cornish mineral, which appears to be a *Hydrated Plumbo-cupric Arsenate.* "Although many mineral species are double compounds of copper and lead (Caledonite, Chileite, Linarite, Vauquelinite, &c.), yet I am not aware of any double arsenate of lead and copper, definite and constant in composition, having been yet discovered and described." (Church.) Bayldonite occurs in minute mammillary concretions having a dusty surface. The structure of the masses is often somewhat reticulated after the manner occasionally observed in certain Travertines. The fracture is slightly conchoidal, uneven, translucent on the edges; colour, grass-green to blackish green; colour of the powder, siskin-green to apple-green; hardness, about 4·5; specific gravity, 5·35; analytical percentages as follows:—

Pb″ O	30·13
Cu″ O	30·88
As_2O_5	31·76
H_2O	4·58
Ferric Oxide and loss	2·65
	100·00

Petroleum is being found in numerous new districts. In California it is discovered in the county of Santa Clara, not far from Gilroy, and a few miles from the route opened between San Juan and Monterey. The sources are on each side of a deep ravine, on the sides of a little river, a tributary to the Panjaro. It is stated that from 20 to 30 barrels of "oil" are obtained in twenty-four hours, but that a much larger quantity was readily obtainable.

A company has been formed for exploring the sources of Petroleum, which are said to be abundant in Zante, one of the Ionian Islands. The occurrence of petroleum in Zante was known at least 2,000 years since, for Herodotus correctly describes the bituminous springs.

An important paper "On the Ores of Manganese and their Uses," appears in the 'Transactions of the Nova Scotian Institute of Natural Science.' An abstract of this paper is given in the 'Chemical News,' November 17th.

Mr. C. Greville Williams has demonstrated the existence of Didymium in "Churchite," as the oxide of Cerium discovered by Professor Church has been called.

Bismuth is said to have been discovered in Spencer's Gulf, South Australia, where a mine is now vigorously working and likely to prove profitable.*

Mr. George Maw, of Broseley, communicates some interesting particulars relative to the occurrence of a very white sand, which is a "perfectly pure form of native silica," occurring in Talargoch mine, near Prestatyn, in Flintshire. One of the lodes in this mine

* 'South Australian Register,' September 27, 1865.

running east and west, nearly vertical and from three to six feet wide, is almost entirely occupied with this silicious sand of the most perfect purity and lustrous whiteness.

An interesting series of experiments "On the Thermo-Electric Tension of Minerals," by Walter Flight, D. Sc., will be found communicated to the 'Philosophical Magazine' for November.

On the line of railway from Estremadura to Portugal occur considerable deposits of Phosphate of Lime. This phosphate of lime attains its maximum of 85 per cent. in the formation of Montanches, six leagues from Caceres and eight miles from Logrosan, its minimum being about 50 per cent. This has been described by M. Luna.* This phosphate is found in the cretaceous strata, and is in great abundance in the silicious bed; it presents a fibrous texture. The following analyses are given:—

	Caceres.	Montanches.
Tribasic Phosphate of Lime . .	72·10	85 03
Oxide of Iron, Silica, &c. . . .	3·85	2·40
Water	3 00	2·22
Carbonate of Lime	—	10·35
Residue insoluble in Nitric Acid .	47·02	—

IX. PHYSICS.

Light.—Professor Mitscherlich has greatly extended the powers of spectrum analysis, by applying it to the detection of the electro-negative elements, chlorine, bromine, and iodine.

The difficulty of recognizing small amounts of these elements in a mixture of haloid salts is well known, and it is found impossible to detect mere traces of these bodies in such mixtures by any hitherto known method. The following means, however, will recognize the smallest amounts of these substances by the use of spectrum apparatus.

The haloid salts of copper are the most difficult to decompose by heat, and they are therefore to be preferred for spectrum investigations, which are best made in the following way:—The substance to be examined, well dried, is intimately mixed with half its weight of sulphate of ammonia and one-tenth its weight of oxide of copper. The mixture is placed in a globular enlargement of a combustion-tube, one end of which is connected with a hydrogen gasometer, the opposite end being open. A stream of hydrogen is passed through the tube, and heat gradually applied to the mixture. The hydrogen being ignited, the first appearance seen in the spectrum apparatus is a brightness in the green, in which, however, no definite spectrum can be perceived, but afterwards the spectrum of the haloid salt of copper is distinctly visible.

When present in small amount, the chlorine compound is best

* 'Compte Rendus.'

recognized by the lines at 105 and 109 and by the brightness near 85 and 87; the bromide compound is detected by the brightness at 85, 88½, and 92; and iodide of copper by the brilliancy at 96, 99, and 102½.

By this method, and without further trouble, ¼ per cent. chlorine, ½ per cent. bromine, and 1 per cent. of iodine are easily recognized, and a practised observer may detect much smaller quantities.

When the haloids are mixed with each other in very small proportions, it is better to precipitate them first by a silver salt. Mix the dried precipitate intimately with twice its weight of oxide of copper, and employ this mixture in the hydrogen before described. By this method as little as $\frac{1}{10}$th per cent. of chlorine, $\frac{1}{9}$th per cent. of bromine, and $\frac{1}{8}$th per cent. of iodine in the silver precipitate can be recognized.

The spectra of the haloid salts appear consecutively, that of the chloride first, then that of the bromide, and lastly that of the iodide of copper. Their appearance in this order depends on the different volatility of these salts. Chloride of copper volatilizes considerably below a red heat, the bromide somewhere near redness, and the iodide at a low red heat. The slower the volatilization is conducted, the more certain are the results of the analysis.

When only traces of iodine and bromine compounds are present in a large excess of a chlorine compound, about the tenth of a gramme of nitrate of silver should be added to the solution. The greater part of the iodine and bromine will be found in the precipitate, which may be tested as before described.

The following results will serve as an illustration of the accuracy and precision of the process. To a pound of common salt which contained no bromine five milligrammes of bromide of sodium were added, and to the solution one decigramme of nitrate of silver. The precipitate was tested in the way just described, and after the spectrum of chloride of copper had been observed for some time, the spectrum of bromide of copper was distinctly visible for five minutes. A further addition of nitrate of silver to the solution gave a precipitate which showed the spectrum for six minutes.

Similar experiments made with iodine compounds gave equally conclusive results, and proved that a ten-millionth part of iodine or bromine may be detected in chloride of sodium.

The residue of six and a half pounds of sea water taken off Heligoland showed the spectrum of the bromide for seven minutes. Iodine could not be recognized, probably because the quantity of water was too small.

A small quantity of water from the Dead Sea showed a large proportion of bromine, but no iodine. The mother-liquor from some salt works showed much bromine, but no iodine.

Some valuable contributions to our knowledge of spectrum analysis have likewise been made by M. E. Diacon. Like Mitscherlich, he has studied the influence of the electro-negative elements on the spectra of metals, most of the researches hitherto communicated having been directed to the electro-positive elements only. The method of analysis founded by Kirchhoff and Bunsen on spectrum observations has given results so remarkable that its utility in chemical researches is not to be contested. Nevertheless, the principle on which it rests is only true under certain determined conditions. From the observations of the author and of M. Mitscherlich, it seems certain that the different compounds of a metal do not exhibit an identical spectrum, and in this paper M. Diacon has collected the experiments which show the influence of the electro-negative element on the radiations emitted by different salts of the same metal. From these experiments, which are far too numerous to admit of being given here in abstract, two consequences result:—

1. The spectra given by Kirchhoff and Bunsen for those of the alkaline earthy metals being the appearances observed at the moment the salt is introduced into the flame, it follows that such spectra must be a mixture of the spectrum of the chlorides and of that of the metal; 2. The appearance of lines not belonging to the metal may be considered as a probable, if not a certain, indication of the existence of a spectrum peculiar to the compound with which it is produced. Thus the study of the lines produced by bromides, iodides, and fluorides in the gas flame may give valuable indications, and furnish new proofs of the existence of a special spectrum for binary compounds. All the metals do not lend themselves with equal facility to these experiments. The best defined results are obtained with the alkaline earthy metals, and with copper and bismuth.

The attentive study of the light emitted by the bromides, iodides, and fluorides demonstrates, then, that the introduction of those salts into a flame determines the appearance of lines which do not exist either in the spectrum of the metals or in that of the chloride. We must, therefore, conclude that these compounds, like the chloride, have peculiar spectra, the superposition of which on that of the metal gives the appearance observed in each of them.

From the author's experiments we learn that spectrum observations give us the means of determining not only the metal but the electro-negative element combined with it. Unfortunately, very definite results are only obtained with a few of these compounds. Although the spectra of the chloride and bromide of copper are very much alike, it is easy to distinguish one from the other, and there are differences in the two spectra easily to distinguish without having recourse to measurement. For example, the position of the greenish blue lines is characteristic of the bromide, that of the violet lines for the chloride. When the two salts are placed in the flame simultaneously, the green lines of the bromide predominate at the first instant; the first of the double indigo line of the chloride is visible; the superposition of the more refrangible rays of the two spectra give rise to new appearances. The presence of the iodide of copper produces no change of importance; and thus it is easy to recognize at least a chloride and a bromide in a mixture of the three salts.

Iodide of bismuth gives the clearest indication of iodine; the spectrum of the salt up to 130 is often ill-defined and difficult to distinguish from the same part of the bromide and chloride spectrum; but the beautiful violet band which terminates that of the iodide is a convincing proof of the presence of iodine.

Fluoride of calcium must always be used to show the spectrum of fluorine. The green line situated about 121 is very brilliant when a very high temperature is employed, and may be considered characteristic of this metalloid.

In some cases the author recommends precipitation with nitrate of silver, but instead of using the silver precipitated in the manner directed by Mitscherlich (see *ante*), he treats it with sulphuretted hydrogen, saturates one part of the acid liquor with oxide of copper, and the other with freshly precipitated oxide of bismuth. The liquid or the dry residue of evaporation may be tested directly in the flame, the one for chlorine and bromine, the other for iodine, as indicated above.

Lastly, M. Diacon repeats that the spectra given by Kirchhoff and Bunsen for the alkaline-earthy metals are a mixture of the spectra of the oxide and the chloride, as are also the spectra given by Mitscherlich as those of the chlorides. In the former, he says, the spectrum of the oxide predominates; in the second, that of the chlorides. A metal, he states, may give different systems of lines, according to the experimental conditions or the nature of the compound experimented upon, and no absolutely specific character can be attached to the spectra given by Kirchhoff and Bunsen; they can only be considered characteristic of the conditions under which they were observed.

The nature of the invisible photographic image has been a never-ceasing subject for discussion amongst scientific photographers. Lately, Mr. Carey Lea,* an experimentalist who stands in the first rank as chemist-photographer, has tried some experiments, which to his mind seem to finally settle the long-contested question as to the nature of the invisible photographic image. The view that the change which takes place in iodo-bromized plates in the camera is a purely physical one, that no chemical decomposition takes place, and neither liberation of iodine nor reduction of silver, has obtained a pretty general acceptance. But latterly it

* 'American Journal of Science and Art.' vol. xi., No. 118.

has been opposed by two distinguished photographers, Dr. Vogel and Major Russel. The former affirms that iodide of silver is never sensitive unless there is a body present capable of taking iodine from it under the influence of light. And the latter believes that the developed image is chiefly produced at the expense of the silver haloid in the film.

The following experiments seem to Mr. Lea to decisively close this controversy in favour of the physical theory:—

Experiment 1.—If the iodide or bromide of silver in the film undergoes decomposition in the camera, and, still more, if the developed image is formed at its expense, the film of iodide-bromide must necessarily be greatly consumed in the development under the dense portions of the negative which it has contributed to form.

To settle this point, an iodo-bromized plate was exposed and developed in the ordinary manner. Then, instead of removing the unchanged iodide and bromide by fixing in the ordinary manner, the developed image was removed, without affecting the iodide and bromide, with the aid of a very weak solution of acid pernitrate of mercury. Now, if the iodide or bromide, or both, had been in any way decomposed, to form, or aid in forming, the developed negative image, when this came to be removed there should have been left a more or less distinct positive image, depending upon varying thicknesses of iodide and bromide in the film, like a fixed negative that had been completely iodized. Nothing of this sort was visible, the film was perfectly uniform, just as dense where an intense sky had been as in those parts which had scarcely received any actinic impression, and looking exactly as it did when it first left the camera, and before any developer had been applied.

Experiment 2.—A plate was treated in all respects as in No. 1, except that the application of the nitrate of mercury for removing the developed image was made by yellow light. The plate, now showing nothing but a uniform yellow film, was carefully washed, and an iron developer, to which nitrate of silver and citric acid had been added, was applied. In this way the original image was reproduced, and came out quite clearly with all its details.

Now, as every trace of a picture and all reduced silver had been removed by the nitrate of mercury, it is by this experiment absolutely demonstrated that the image is a purely physical one, and that after having served to produce one picture, that picture may be dissolved off, and the same physical impression may be made to produce a second picture by a simple application of a developing agent.

Mr. F. H. Wenham, a gentleman well known in all scientific circles by his admirable device for securing binocular vision in the microscope, has communicated to the Microscopical Society some interesting notes on the Fracture of Polished Glass Surface.

It is a fact known to the philosophical instrument makers that if a metal wire be drawn through a glass tube, a few hours afterwards the tube will burst into fragments. The annealed glass tubes used for the water-gauges of steam-boilers are sometimes destroyed in this way, after the act of forcing a piece of cotton waste through them with a wire for the purpose of cleaning the bore. This will not happen if a piece of soft wood is employed. After having drawn the point of a steel burnisher over the surface of a slip of polished glass, the following appearances will be observed under the microscope, using the polarizing apparatus and selenite, with a two-thirds object-glass. A coloured stripe is visible in the passage of the burnisher, showing that the surface of the glass has been placed in a state of tension in the direction of the line. The glass, too, seems not altogether devoid of plasticity, for the waves of colour show that it has been carried forward in ripples, resembling the mark left on a leather-bound book after the passage of a blunt point. It may be inferred from this that the mere burnishing of the surface of the glass with a substance inferior in hardness will, without any scratching, cause an irregular strain in the bore of tubes sufficient to split them, and the concussion attendant upon the fracture often reduces the tube to small fragments.

If the burnished lines upon the glass slip be examined a few days afterwards, the colours will have become much less visible, showing that the strained portions of the glass partly recovers its equilibrium.

On attempting to polish out a minute scratch on the surface of a piece of glass, it sometimes appears to widen during the process, and at length resolves itself into two irregular parallel rows. Also, a clear cut made with a diamond on a piece of plate-glass, if left for a time, the surface in the vicinity of the cut will break up, forming a coarse irregular line. If the diamond be raised and struck lightly on the surface of the glass, the form of the edges of the short stroke thus made may be plainly seen, using the binocular polariscope. A conical ridge of glass appears to be left with its apex under the line of the cut, and the glass is frequently wedged up on both sides of the ridge, explaining the cause of the double line of fracture which sometimes makes its appearance in polishing out a scratch. This effect may also be exemplified by observing the marks left on a polished glass surface from the light blows of a steel centre-punch. The point of the punch drives in an atom of glass, and the fracture extends some distance into the interior, expanding downwards in the form of a truncated cone. The polariscope shows that the conical centre is in a state of compression, and that the surrounding exterior portion of glass is also under strain.

The smooth, round edge of a glazier's diamond, when drawn of a polished glass surface, burnishes down and compresses the glass beneath the cut, and in the case of thin sheets the wedge-like force of the compressed line splits the glass nearly through; but when the glass is thick and rigid, as plate-glass, unless the sheet is bent back and broken through immediately after the cut, greater difficulty will be experienced if allowed to remain for a time, for the compressed line of glass will speedily tear up the portion on both sides, leaving a wide ragged groove in place of the original clean and scarcely visible line.

A paper on the Spectrum of Nitrogen has been communicated to the Parisian Chemical Society by M. Waltenhofen, who states that in an atmosphere of nitrogen properly rarefied, the violet rays disappear before the blue and green. The author's observations lead him to believe that nitrogen is a compound body. This opinion is gradually gaining ground amongst physicists who have paid attention to the electrical spectra afforded by nitrogen under varying conditions of rarefaction and intensity.

Heat.—A discussion has lately taken place before the Manchester Literary and Philosophical Society respecting the possibility of utilizing the internal heat of the earth as a source of motive power. Mr. G. Greaves, M.R.C.S., at the October meeting of the Society, stated that it had been very generally admitted that coal will not cease to be furnished because of the exhaustion of the stores of the mineral now existing in the coal measures; and further, that the obstacles to the continued working of the mines will not be engineering difficulties. The increased depth from which the coal will have to be brought may add to the cost, but at that increased cost it will still be for a long time obtainable. The author considered the real unsurmountable obstacle to be the high temperature of the lower portions of the carboniferous strata. The temperature had been shown to be at a depth of 4,000 feet, at least 120° Fahr., a degree of heat in which human beings cannot exist for any length of time, much less use any exertion. It had occurred to the author to inquire whether the very agency which will prevent the continued supply of fossil fuel might not be made the means of rendering that supply unnecessary—whether, in short, the internal heat of the earth might not to some extent be utilized. One or two modes of doing this had presented themselves to his mind. One of these might, he conceived, be the direct production of steam-power by bringing a supply of water from the surface in contact with the heated strata by means of artesian borings or otherwise.

This elicited a letter from Sir J. F. W. Herschel, saying that by employing condensed air, conveyed through conducting pipes, as a mode of working machinery at that depth—provided the air immediately on its condensation, and before its introduction into the pit, were drained of the heat developed in the act of condensation, by leading it, in pipes exposing a large external surface, through a sufficiently large supply of cold water (or in winter time of snow), the workings below might be sufficiently reduced in temperature by the re-expansion of the air on its escape, when given out below in the act of working the machinery, to admit of workmen remaining there in comfort; at the same time the ventilation could be supplied. Water at 120° Fahr., or even much higher, would, he feared, afford but an inefficient moving power, unless some means could be devised (without the expense of more power than the gain expected) of concentrating the heat of a large quantity of warm water into a smaller. This might, perhaps, be done through the intervention of air alternately rarefied and condensed. In the discussion on this letter Mr. Binney said that at the present time little was known as to the difficulties we should experience in working coal mines at a depth of 4,000 feet from the surface. The exact increase of temperature in deep mines was not by any means well ascertained. All we can say is, that no great difficulties have been found in working at a depth of 2,100 feet. It must always be borne in mind that the deeper a mine is the greater will be the natural ventilation; that is, the current caused by the air of the mine, at say a temperature of 80° Fahr., ascending the upcast shaft, while the air at the surface, of 40°, descends by the downcast shaft. No doubt a mine might be cooled by the expansion of compressed air, but it could not, so far as at present known, be done economically. In most deep mines a considerable cooling of the air takes place by the expansion of the compressed gas (light carburetted hydrogen) as it escapes from the coal, where it has been long imprisoned under great pressure; and this has not always been allowed for by observers of temperature in such places.

Mr. Pouchet has given the result of some very important experiments on the congelation of animals to the French Academy. The experiments entirely negative the popular idea that an animal slowly congealed may be kept so, and restored to life at any future time by careful thawing; and show that an animal whose body is reduced to the freezing point throughout, is killed beyond all chance of revivification. The experiments have great physiological interest, and our readers will no doubt be glad to learn the author's conclusions. These are:—

1. That the first phenomenon produced by cold is a contraction of the capillary vessels to such an extent that a globule of blood cannot enter, these vessels therefore remain completely empty.

2. The second phenomenon is an alteration of the blood globules, which amounts to their complete disorganization.

3. Every animal completely frozen is absolutely dead, and no power can reanimate it.

4. When only a part is frozen, that part is destroyed by gangrene.

5. If the part frozen is not extensive, and only a few disorganized blood globules pass into the circulation, the animal may recover.

6. But if, on the contrary, the frozen part is of considerable extent, then the mass of altered globules brought into the circulation when the part is thawed, rapidly kills the animal.

7. For this reason a half-frozen animal may live a long time if maintained in the condition, since the altered globules do not get into the circulation, but it expires rapidly as soon as the frozen part is thawed.

8. In all cases of congelation, death is due to the alteration of the blood globules, and not to any effect on the nervous system.

9. It results from these facts that the less rapidly a frozen part is thawed, the more slowly the altered globules find their way into the circulation, and the greater are the chances of the recovery of the animal.

The Abbé Moigno gives, in his valuable review 'Les Mondes,' a short description of an ice-making machine now in operation here. The inventor, M. Menard, employs ether, which is compressed to the extent of from five to seven atmospheres. From the reservoir the liquid is allowed to escape into a worm, circulating round square vessels of water, which become frozen by vaporization of the ether in the worm. The machine will produce, it is said, fifty kilogrammes of ice per hour.

Electricity. — The highly electro-positive metal Magnesium would be invaluable to electricians if it could be got for the same price as zinc; already it is being proposed for use in certain electrical apparatus, and at a recent meeting of the French Academy, M. Bultinck presented a note on the Use of Magnesium in Voltaic Piles in place of Zinc. The author shows that a short chain of twenty elements, each composed of thirty-five millimetres of thin silver and magnesium wires, wound about pieces of caoutchouc and properly connected, will produce all the effects, chemical, physical, and physiological, of a long Pulvermacher's chain when simply moistened with pure water.

It is announced that the two lighthouses at Havre will now be definitely illuminated by electricity, that all difficulties in the way of producing a constant light by induction machines have now been overcome by the Alliance Company. The machines will be driven by a six-horse power locomotive engine, which will also compress air for whistles or trumpets to be used as fog signals.

X. ZOOLOGY AND ANIMAL PHYSIOLOGY, INCLUDING MICROSCOPY.

The Boston Society of Natural History have issued the subjects for the Walker prizes, *viz.* Annual prizes of sixty and fifty dollars;—subject for 1865-66: "Adduce and discuss the evidences of the co-existence of man and extinct animals, with a view of determining the limits of his antiquity;"—for 1866-67: "The fertilization of plants by the agency of insects, in reference both to cases where this agency is absolutely necessary, and where it is only accessory." There is also a grand honorary prize for 1870, to which the sum of 500 dollars may be awarded, for such scientific investigation or discovery in natural history as they may think deserving thereof, provided such investigation shall have first been made known and published in the United States of America. In case the merit of the investigation or discovery be extraordinary, the Council may award 1,000 dollars.

Mr. J. G. Shute has made an interesting communication to the Boston Society of Natural History, upon the method of transference of the new-born marsupial into the maternal pouch. It was seen by him to take place in the case of the opossum (didelphys virginica). During the delivery of the young the parent lay upon the right side, with the body curved in such a manner as to bring the vulva nearly opposite the mouth of the pouch, which was opened, or drawn down, by contraction of the muscles, so as to receive the young when delivered. The young ones were seven in number, and the time occupied in the delivery about four hours. The parent remained in the same position about thirty-six hours, and refused all sustenance. Immediately after the transfer of the young to the pouch Mr. Shute removed one, by detaching it from the teat, in order to ascertain if the movement of the fœtus was instinctive. He found that it was at least partly voluntary, as it made an effort to regain its place in the pouch; and the same movement was made on the part of the parent to receive it as at first. He did not notice any use of the lips or limbs of the parent during the transfer.

The Rev. Professor Haughton, who lately made some curious researches into the anatomy of the leg of the ostrich, with a view to discover the secret of its singular movements, has carried on his observations by examining the hind-leg of the crocodile. To this, he says, he was incited by the late Professor Gratiolet, who assured him he should find in it a problem, exceeding in complexity that presented by the leg of the ostrich. In the Annals of Natural History he details the description of the muscles, and finds the prediction of the anatomist fully borne out. The interlacing of the muscles in the thigh and leg of the crocodile is, he says, very remarkable, and even more complex than in the ostrich. At first he was disposed to think it threw some doubt upon the explanation he had previously given of the reason for such an arrangement in the bird's leg, as there did not appear so much reason for it in the case of the crocodile; but he subsequently came to an enormous deep muscle (the extensor femoris caudalis), originating from the transverse and inferior spinous processes of the caudal vertebræ, and inserted into the back of the upper part of the femur, and into a great round tendon, which, passing down the back of the femur, is inserted by a common aponeurosis into the outer condyle and the head of the fibula. The effect of the interlacing of the tendons of the various muscles is to produce simultaneity of action among them, as in the ostrich; and in the crocodile there seems to be a similar principle involved. The crocodile, resting on mud, progresses chiefly by using his hind feet as paddles; and in this use of them, the great caudal extensor of the thigh is the most powerful and important muscle employed. The simultaneity of action of all parts of the leg, rendered necessary by the employment of so powerful a muscle, is fully secured by the interlacing of the tendons, which renders it impossible for one set of muscles to act without the others being also exerted.

M. Matteucci gives an account, in 'Comptes Rendus,' of some experiments upon the electro-motor power organs of the Torpedo, in a state of repose, *i.e.* which gave no sensible discharge to a delicate galvanometer; and he finds under certain circumstances that a constant current is present, which deflects the galvanometer with a persistent deviation. This electro-motor power notably increases after the piece of the organ has been forced to give a discharge by irritating the nerves. And in torpedos taken in warm seasons, when out of water they very rapidly lose their electric function, and the electro-motor power of which is almost nil, by irritating the nerves of the organ, or by rounding the fourth (electric) lobe, the electro-motor power suddenly reappeared, and persisted for some time. M. Matteucci has endeavoured to verify the observations of M. Robin, made some years back, with regard to the organs analogous to the electric organ of the Torpedo, which he supposed to be possessed in certain rays. He had already tried without success, but supposing the failure might possibly be owing to his having operated on very small and sluggish fish, he, with the assistance of M. Schiff, operated upon a tolerably large and vivacious ray, and having forced the fish to a series of strong contractions, M. Matteucci obtained, by the galvanoscopic frog, the exposed nerve of which was placed upon the organ in question, manifest signs of electric discharges. This experiment he pledges himself to repeat and corroborate, and remarks that the difference in the dimensions and number of the elementary cellules, and the nerves of the electric organ of the ray and those of the other electric fishes gives a great importance to the study of that function in the ray, and this study should explain the peculiar electric phenomena discovered by M. Robin in the electric function of the ray, and which are not exemplified in the other electric fishes.

Dr. Mörch proposes a new classification of the Mollusca ('Annals,' December), inasmuch as he regards the organs employed in adopted classifications to have less systematic value than is usually attributed to them. The locomotive organs, on which were founded Cuvier's primary divisions, Cephalopoda, Gasteropoda, &c., have been found by subsequent researches to have been somewhat misunderstood, at all events in their homological relations. Thus, Lovén and Huxley have shown that the Pteropods are true Gasteropods, and that the funnel of the Cephalopods is homologous with the foot of the Gymnosomata. The secondary divisions (or orders) of Cuvier were founded upon the respiratory organs, but special organs for this function are not always necessary. In Mollusca not requiring a hard covering for their protection, respiration takes place through the skin; but when the skin is thickened, or the shell developed, a respiratory organ becomes necessary. The larger the shell is in proportion to the uncovered parts of the animal, the more complicated and compressed are the gills. The insignificance of the gills as a systematic character is evident by comparing the Heteropoda, from the entirely gill-less Firoloids and Pterotrachæa with external gills, to Atlanta exhibiting perfectly internal gills. The two kinds of respiratory organs indicate only relative superiority and inferiority, but not the limits of systematic division. Neither is the presence or absence of a head, though indicating relative superiority or inferiority, sufficient for natural divisions. Dr. Mörch, after twenty years' study, is enabled to state that the heart and generative organs offer characters of a much higher systematic value than is generally believed, and the classification proposed by him is chiefly founded upon the male organ, which seems to him to be the best indicator of the sensibility of the nervous system, and consequently of the relative systematic rank of the animal. His synopsis confirms the rule of Professor Agassiz, that land animals are more perfect than marine; but this rule may be explained in the sense that the divisions with the largest number of terrestrial forms always are the superior. The lowest class, Acephala, is entirely aquatic, and chiefly marine. There is also the same concordance with Professor Owen's law, that the multiplicity of organs indicates inferiority in organization. Thus the duplicity of the organs of Acephala descends as the system ascends.

M. Paul Rocher, in a paper brought before the Academy of Sciences, makes some interesting observations upon the manner in which terrestrial Mollusks obtain food under circumstances of extreme drought. Travelling in the south of the province of Oran, in Algeria, he had occasion to notice great numbers of them in the steppes of the desert, and proved that they derived the water necessary for their nourishment from certain of those succulent plants which grow spontaneously in arid situations, such as Atriplex halimus. This plant appears also to be the chief food of the Meah antelope, which, the Arabs say, lives several years without drinking. Another such plant is the Bou gerba, or bottle plant, upon which he has seen nearly every morning, while there was still some freshness in the air, hundreds of snails agglutinated. These Mollusks can exist for a long time without food, and are furnished, moreover, with a solid operculum, while the white colour, which appears to be characteristic of all the Saharian animals, defends them to a certain extent from the heat of the sun. Their shell also is relatively thick, for they all live upon the calcareous or saline plateaux of the desert, where they find abundance of material for the formation of their testaceous envelope.

Dr. Phipson, in 'Cosmos,' states that lately, being at Marburg, he observed, about 10 P.M., certain luminous insects flying in the air on the banks of the river. On securing one, he found it to be a male *Lampyris splendidula*, proving that the male Lampyri enjoy the faculty of emitting light, about which there was previously some doubt. But M. Schultze has described, more than a year ago, the structure of the luminous organs of these very same male insects, the tracheæ of which he finds to be terminated in a small cell of stellate form, which rapidly acquire a black tinge under the action of osmric acid, the cells of the parenchyma remaining uncoloured.

Dr. Walsh describes, in 'Silliman's Journal,' some very curious effects produced upon insects apparently by the material of their food, from which he is led to believe that otherwise identical insects differ, as varieties or species, according to the species of plant they feed upon. This difference of food may have very various results: sometimes it is accompanied by no difference whatever either in the larva, pupa, or imago state; but it may coincide with a marked difference in the colour of the silk-producing secretions, or a tendency towards the obliteration of the normal dark markings in the imago; or marked, but not perfectly constant, colorational differences in the larva, but none whatever in the imago; or by a marked and perfectly constant difference in the size of the imago; or by a marked difference in the chemical properties of the gall-producing secretions, the external character of the imago remaining identical; or by a slight but constant change in the coloration of the abdomen of the imago, and a very slight change in the chemical properties of the gall-producing secretions; or by one marked and perfectly constant colorational difference, and others which are not perfectly constant in the larva, but none whatever in the imago; or by several slight, but constant structural differences in the male imago, but none whatever in the female; or by a slight but constant structural difference in both male and female imago; or by very strong structural and colorational differences in the larva, and in all probability by a constant structural difference of generic value in the female imago, the males being to all external appearance identical, and the two insects belonging to different genera; or lastly, by marked and constant differences, either colorational or structural, or both, in the larva, pupa, or imago states. Of each of these he gives examples; and remarks that for his own part, as on the most careful consideration he is unable to draw any definite line in the above series, and to say with certainty that here end the varieties, and here begin the species, he is therefore irresistibly led to believe that the varieties gradually strengthen and become developed into species, and that the difference between them is merely one of mode and degree.

Professor Claus finds that in the Ostracode division of Crustacea, the heart is sometimes present and sometimes absent. This remarkable fact was demonstrated by the discovery of a heart beating with regular pulsations in *Cypridinæ*, while it is known that in the other two families, Cypridæ and Cytheridæ, the heart is absent. The same curious circumstances obtain in the Copepoda, of which the families Cyclopidæ, Harpactidæ, and Corycæida possess no heart, while in the other two families, Pontellidæ and Calanidæ, it is always present. M. Claus has also detected in the Cypridinæ, in addition to the large, paired, compound eye, an accessory single eye, simple and median, perfectly similar to that which exists in addition to the compound eye, in the Daphniæ. The Cypridinæ thus appear to differ widely from the other two Ostracode families, not only in these respects, but also as regards their appendages, the three anterior pairs of which are employed by them as locomotive organs, as is the case with all Entomostraca during their Nauplius phase.

It is very unfortunate that disputes should arise upon scientific questions to such a degree as that either disputant should indulge in personalities, but the scientific world has been of late anything but edified by the discussions between Dr. Carpenter and Professor William King of Belfast. The foraminiferous character of the fossil Eozöon canadense, distinctly asserted and minutely described by Dr. Carpenter, has been attacked by Dr. King, and much heat is introduced into the discussion. Another subject sets them also at variance, a matter of fact depending upon experience and acuteness of observation, *viz.* the microscopic structure of the shell of

Rhynchonella Geinitziana, which Dr. Carpenter describes as imperforate as regards the outer layer, while Professor King declares it to be perforated. Dr. Carpenter expresses himself fairly enough, as prepared to meet with perforated Rhynchonellidæ, although *imperforation* is the family character; but a careful examination with the binocular microscope and a magnifying power of 120 diameters upon transparent lamellæ and sections, makes him feel justified in reiterating his statement that the passages which are visible in the shell, traverse the internal layer only, and are therefore pits and not canals, while it appears that Prof ssor King's observations have been made upon the exposed surfaces of his specimens, with a Stanhope lens only. It does certainly appear to us presumptuous, to say the least, in any observer to be content with such imperfect appliances and inadequate observation, to challenge with such boldness the results of so careful and trustworthy an observer as Dr. Carpenter. Inasmuch, however, as this is the third case of a similar kind in which Professor King has come into collision with Dr. Carpenter, we cannot help fearing it is the result of an antagonism which, for Professor King's reputation, is much to be regretted.

Dr. Beale states that the best way of studying muscular contraction is to examine the larva of the flesh fly. The movements continue for ten minutes or a quarter of an hour after the muscles are detached from a freshly killed larva, and in winter for as much as half-an-hour. The best way to see them is by polarized light, by the aid of a plate of crystallized gypsum. When the body colour is green, the waves of contraction which are propagated along each muscular fibre in different directions are of a brilliant purple. In other parts of the field the complementary colours are reversed. With very high powers, it is easy to observe the change which takes place in the contractile tissue itself, each time that it passes from the state of contraction to that of relaxation, and back again, and that for several minutes at a time.

Mr. H. L. Smith of Kenyon College describes in 'Silliman's Journal' an apparatus by means of which he keeps Diatomaceæ alive for a long time under the microscope, for the purpose of observing the phenomena of conjugation. It is a slide, which is a trifle more than an eighth of an inch in thickness, and consists of two rectangular glass plates, 3 inches by 2, and $\frac{1}{25}$th inch thick; separated by thin strips of glass of the same thickness, cemented to the interior opposed faces, thus forming a closed cell to be filled with water, and upon which the achromatic condenser can be brought to bear. A small hole is drilled through the upper plate, and one corner of the upper glass is removed. The space between the two plates is then to be filled with clean water by means of a pipette, a drop being placed upon the drilled hole to remove the air. The object being put on the top of the slide and wetted, is then to be covered with a large square of thin glass, which covers the drilled hole, and is prevented from slipping by a small strip cemented as a ledge under it. The slide can now be placed upright, or in any position, and no water can escape. As the water evaporates from under the cover, more is supplied through the hole, and from time to time an air bubble enters at the removed corner of the upper plate, so that a constant circulation is kept up. The cell needs replenishing only about once in three days, and this may be done without disturbing the object. It is in fact only a new application of the old principle of the bird fountain.

The science of Zoology has sustained great losses of late in the death of three eminent conchologists. The first of these was the well-known traveller and collector, Mr. Hugh Cuming, who had devoted many years to the investigation of the Natural History of South America and the Eastern Archipelago, where he gathered the richest collection ever brought home by a single traveller, which has rendered his cabinet of shells the most remarkable in Europe. We understand this collection has been offered to the British Museum for a sum of money much beneath its value, and has been accepted. The second conchologist whose loss we have to deplore, is Mr. S. P. Woodward, the author of the best manual of conchology we have. Mr. Woodward was engaged in the British Museum, and his knowledge of shells was most extensive. He had long suffered from an asthmatic affection, which finally carried him off. We have more lately lost an enterprising and learned conchologist in Mr. Lovell Reeve, whose "Conchologia Iconica" is his best monument, a work which, having reached fourteen or fifteen volumes, copiously illustrated, is nevertheless unfortunately far from being completed.

ANNUAL RETROSPECT.

The year 1865 has been characterized by slow, steady progress, rather than by any brilliant achievements in science, and if we were to look for striking events in the record of the past year, we should be met by failure and death, rather than by notable successes or the birth of genius.

The second failure of the attempt to lay the Atlantic cable, although the postponement of what appears to be a certain success, will serve to remind scientific men how slow and laborious must always be the conquest of the elements; and though we cannot say to the enterprising electricians, "go to the ant, thou sluggard," still we must point to the humble little spider, which spins and spins its line, failing again and again in reaching the desired point, until perseverance triumphs and the goal is attained.

And when we look at men instead of measures, how destructive do we find the scythe of time, or the ravages of disease, to have been during the past year. At once the names of Fitzroy, Hooker, Lindley, Falconer, Gratiolet, Silliman, Baikie, Tinné, Reeve, Woodward, Christy, and Waterton sound in our ears, and in every branch of science do we find a gap of greater or less proportions.

To the memory of one of these chiefly—namely, the first, do we desire to pay a special tribute of praise, and it is indeed a selfish feeling that prompts the distinction, for we feel that few men could have been spared with more serious consequences to their fellow-men. Already Admiral Fitzroy's researches in Meteorology, and his practical application of the science, had effected an amount of good which it is impossible to estimate. Who can say how many lives he saved? Who can tell how many more would have been spared had he continued to live? We have no wish to disparage the efforts of his successors who seek to follow in his wake: quite the reverse; we would have them profit by his example, and endeavour to develop the unfinished work of his life. But it is idle to attempt to hide the fact that his knowledge, acquired, no doubt, in a large degree by personal experience, has not survived him in its entirety, and that his followers must to a certain extent begin *de novo*, and repeat his experiences before they can even hope to attain his power of benefiting the seafaring man by forecasts of the weather.

We are hopeful, however, that the work which is being carried out over the large field of Europe, by Le Verrier, may lead to a more perfect knowledge of the laws by which the atmospheric currents are regulated, and thus place in our hands that kind of information which we require to guard us from the destructive violence of the winds. In connection with Meteorology, much interest attaches to the balloon ascents made by day and night by Mr. Glaisher. Although a large number of observations have been made with all the care possible under the circumstances, many more aërial journeys will be requisite before the numerous conditions connected with terrestrial radiation and the influences of heat and electricity on atmospheric phenomena can be recorded. Then it will still remain undetermined whether the results observed are constant or varying. We are gathering a large amount of knowledge in this branch of science, but we must be content to wait, never ceasing to work, for the development of the laws which shall embrace the apparently irregular phenomena with which we have to deal.

In this work it is the duty of all who are able to give any assistance, to render it cheerfully and zealously, and there is one phase of the subject to which semi-scientific or even unscientific observers of meteorological phenomena may with advantage direct their attention; we mean the measurement of the rainfall in their own particular localities. A committee, consisting of Mr. Glaisher, Lord Wrottesley, Professor Phillips, Professor Tyndall, Dr. Lee, Mr. Bateman, Mr. Mylne, and Mr. G. J. Symons has been appointed to collect information on this subject, and the last-named gentleman* has issued a circular to the press, in which he gives the localities and elevations at which, to the knowledge of the Committee, observations have been made since the year 1766, and asks for information on the subject of the British Rainfall from all who are willing to collect suitable data. No doubt there will be plenty of volunteers to provide the requisite information.

One point of great interest in connection with this of science ap-

* Whose address is 136, Camden-road, London, N.W.

pears to have been determined—namely, that the solar heat-rays pass through space without loss, and become effective only where wanted; and, in proportion to the density of the atmosphere or the amount of water present in that through which they pass. If it be so, the proportion of heat received at Mercury, Venus, Jupiter, and Saturn may be the same as that received at the Earth, notwithstanding their different distances from the sun.

Many subjects of much interest in this division of science engaged the attention of the Physical section of the British Association; amongst others, a self-recording anemometer was exhibited by Mr. S. B. Howlett, and some of the records shown. This ingenious instrument appeared to indicate that even the light breezes of summer have a tendency to move in circles, or to describe longer or shorter ovals, in their course. We learn that this apparatus is being manufactured at a moderate cost, and hence we hope that ere another year passes by, we may be in a position to report its capabilities and indications when used on a more extended scale.

Although belonging to another division of Experimental Science, still, as having immediate relation to the above subjects, Professor Tyndall's researches on the Heat Spectrum, and especially on the phenomena to which he has given the name of *Calorescence*, must be regarded as of considerable importance.

In the history of this interesting inquiry, the researches of Herschel (the elder), of Schenck, and especially of Melloni, must not be forgotten. We would especially direct attention to Melloni's memoirs on '*A New Nomenclature for the Science of Calorific Radiations.*'* The application of prismatic analysis to the objects in the heavens has been continued with much success. Mr. W. Huggins appears to have proved the gaseity of the nebulæ, and thus to have restored, to some extent, confidence in the "nebulous fluid" of Sir W. Herschel, from which by subsidence and condensation stars are supposed to be elaborated. Father Secchi, from a careful examination of the spectrum of Jupiter, shows that the atmosphere of that planet has a peculiar and strong absorbing power, different from the atmosphere of the Earth. He thus advances towards the proof required by Mr. Glaisher's observations,

* 'Bibliothèque Universelle de Genève,' No. 70, for October, 1841. Translated in 'Scientific Memoirs,' vol. iii., part 12.

that planets, according to their positions in space, are physically so constituted as to suffer nothing from any loss of solar heat or light.

The question of the existence of an atmosphere in the Moon is re-opened by the fact observed by Mr. Huggins, that the *spectrum* of a star a little before and at the moment of its occultation by the dark limb of the Moon, exhibited several phenomena characteristic of the passage of the star's light through an atmosphere. The indications which will be found in our *Chronicles* of the advances of knowledge in this direction, by the aid of spectrum analysis and astronomical photography, would lead us to believe that many of our views respecting the conditions of planets and stars will receive considerable modification, if they are not destined to undergo an entire change. The solar photosphere and the solar spots have received a large share of the attention of astronomers. A great number of remarkable phenomena have been observed, but it would be premature to state that any positive facts had been determined. It is most satisfactory to know that the Hofrath Schwabe has given the Royal Astronomical Society his valuable collection of sun-drawings, and his solar observations from 1825 to the end of 1864. This, the most remarkable series of continuous observations ever made by a single man, has enabled us to determine the law of periodicity observed by the solar spots. The 'Researches on Solar Physics' by De la Rue, Stewart, and Loewy, of which the first series has recently been published, brings all the observations together, and thus greatly aids the inquiry. Professor John Phillips and Mr. Dawes have been directing their well-trained attention to the planet Mars. They are rendering us well acquainted with the physical features of that planet, and proving the repetition of many terrestrial phenomena upon it, showing, indeed, that the character of the climate of Mars is not very different from that of our great continents.

Passing from Astronomy and the applications of Chemistry to the necessities of that science, we must briefly remark on the progress made by chemists during 1865. The period has been one of considerable anxiety; to many, a period of transition is always so. The unmanageable names which the necessities of discoveries in organic chemistry have introduced, has rendered necessary the introduction of a more precise and satisfactory system of notation than that at present in use. There exists much difference of opinion upon this question. The discussions which have taken place have not produced anything approaching to uniformity in the notation of even modern chemists; while those of the older schools see nothing but confusion in the systems proposed—adopted—modified—and abandoned in succession. It is to be hoped that from amongst the ranks of our young chemists, many of whom exhibit great originality of thought and considerable mental power, some one will seriously undertake the task of reducing the overburthened system which is now adopted to a state of simplicity and order.

Investigations have been steadily carried forward in connection with the new and rare metals with which spectrum analysis made us acquainted; and new sources from which these metals can be obtained, have been discovered.

Mr. H. C. Sorby, with his usual ingenuity, has applied spectrum analysis to the Microscope, and has employed it in making some important investigations on the detection of blood-stains. Considerable advances have been made in determining the positions, numbers, and conditions of the dark lines in the solar spectrum and their agreement with the lines produced by known substances.

Much interest was excited by a published statement that *antozone* had been isolated by Schönbein, and the compound condition of oxygen determined. This has not been done; indeed the existence of such a body as antozone is somewhat problematical. It is, however, satisfactory to see that the evidence on the peculiarities and properties of ozone are accumulating, and proving this allotropic state of oxygen to be of high importance in the economy of nature.

Inorganic chemistry has discovered several new minerals, and many inquiries of much practical importance have been carried out.

Weil, by his simple process of coating one metal with another, without the aid of a voltaic battery, has introduced a process which must greatly extend the advantages of electro-metallurgy.

Deville and Troost, by their discovery of the permeability of certain dense metals at elevated temperatures to gases, have opened a most curious inquiry on the boundary line between physics and chemistry. Deville's experiments on the phenomena of *dissociation*, or the partial decomposition of compound gases under the influence of temperatures more or less elevated, have been continued with many important results, and lead, or are leading, to an explanation of some of the anomalies which have hitherto beset the laws of gaseous volumes, and the molecular theories of their constitution.

Gun-cotton, nitro-glycerine, and several new gunpowders have been submitted to trial by practical men, with, as reported, very variable advantages. Gale's process for rendering gunpowder non-explosive for stowage and transport has been taken up by a public company; but we believe it has not been applied on the large scale. Its real value has, therefore, yet to be determined.

Mr. Crookes's new and interesting process of increasing the amalgamating power of mercury by the aid of sodium has been rendered free from any of the objections which at first stood in the way of its adoption, and is now employed with much success and economy.

Organic Chemistry still advances in the direction of those synthetical proofs of transformations which constitute its most striking feature. The researches of Frankland and Duppa, and of several of the German chemists, are progressing towards that "grand conception," which seems to inspire Dr. Hofmann, "of a natural classification of chemical bodies into genera and species, each distinguished by well-marked characteristics, not excluding individual varieties, but grouping them in subordination to collective laws."

The value of chemical inquiry becomes most apparent when it is skilfully applied to the improvement of manufactures, or to the removal of the injurious effects arising from them. In the first Annual Report of Dr. Angus Smith, the Inspector under the Alkali Act, we have satisfactory evidence of this. The whole question of the condensation of noxious gases is fully dealt with, and if Dr. Angus Smith's knowledge as applied to this end, is only seconded by the attention of the manufacturer, all cause of complaint will speedily be removed from the alkali manufacture.

Chemistry is naturally allied to metallurgy, and we find during the year considerable evidence of the activity with which experiments have been made to improve the processes or their results. Iron has especially claimed the attention of the French chemists, and some promising results have been reported. Experience shows that we are steadily advancing towards the conversion of iron directly into cast steel, by other and more, strictly speaking, chemical processes than those now in use.

Puddling, although a mechanical process, is in its results, as nearly every metallurgical process is, a chemical one. The application of machinery, to produce the proper oxidation of the carbon in the iron, has been extended and improved. We hear, however, of large experiments which promise results superior to any which have yet been obtained, in the production of merchant iron.

One of the most important improvements which have been introduced, is the utilization of the copper-smoke of the great copper-smelting establishments of Swansea. That which has been for many years a great nuisance to the neighbourhood, and by which vegetation has been destroyed for many miles around the works, is, at the establishment of the Messrs. Vivian and Sons, now converted into sulphuric acid, an article of commercial value.

Metallurgy is directly dependent, for the material upon which it operates, on Mining. Our journal shows that science has been called in to aid in removing those evils which surround a life of subterranean toil, and by which the miner perishes in the prime of life. The Mines Commission in their Report have proved, upon the evidence of the most accomplished experimentalists, that the air of our metalliferous mines is seldom in such a state as will ensure the continuance of health. An attempt was made by Lord Kinnaird to pass an Act to regulate the conditions under which our metal mines are worked. His lordship was induced by the Government to withdraw the bill which he introduced, but this was followed by the production of a second bill, somewhat modified, which will come under the consideration of the House of Lords early in the ensuing session.

The application of the law of the diffusion of gases to the detection of fire-damp in collieries has been experimented on, upon a large scale, in the Hetton collieries.* The instrument invented by Mr. Ansell, of the Royal Mint, has answered most completely. We

* While these pages have been passing through the press, the chief proprietor of these collieries, Mr. Nicholas Wood, F.R.S., has been removed from among us. Mr. Nicholas Wood has ever been the promoter of scientific applications to the necessities of colliery operations. He belonged to a group of superior men, being the friend and associate of Stephenson and of Buddle. His loss is a severe one to the Newcastle district.

learn that a continued series of experiments is about to be made, even if they are not now in progress, in the fiery collieries of the South Yorkshire district.

The continuation of the production of gold from the quartz veins of the Welsh mountains is giving the promise of a return for the large expenditure which has been made. The settlement of the war in America has led to an advance in the price of tin, and the blockade of the Chilian ports has produced the same effect on copper, so that peace on one hand, and war on the other, are equally benefiting the British miner.

Attention having been drawn to the value of the bituminous shales, sandstones, and clays, we find that these sources of "mineral oil" are discovered in every quarter of the globe. The experiments on the use of petroleum as a fuel for steam boilers appears to have been thoroughly successful. Therefore we may expect that the large supplies of the material promised will be required to meet the new demand. The most remarkable discovery of mineral treasure recently made, appears to be that of silver in the Nevada territory, where a new Potosi is actually developing its treasures.

Agriculture has been seeking the aid of the sciences for its improvement. It has been proved that sewage manure has a remarkable fertilizing effect upon some grass lands; judgment is, however, required in its application, but with that judgment we hope we shall not be much longer subject to the rebuke of annually pouring into the sea at Barking 100,000,000 tons of food-producing material.

The want of calculation, of forethought, on the part of men has been strikingly shown by the ill-judged extension of the drainage of land. The rain falls on the land, and in a few hours it has been carried off by the rivers to the sea; consequently, when a short period of dry weather supervenes, the farmer finds his crops perish through the want of water. Irrigation, therefore, has all at once become the question of the hour, and we find the Agricultural Society of England pressing the subject upon the farmer by the assistance of their chemist, Dr. Voelcker.

There is a continued earnest desire on the part of our leading agriculturists to extend the benefits of professional agricultural education by the establishment of clubs, schools, and colleges devoted to practical agriculture.

The value of scientific education is becoming more evidently felt, and the science classes established in connection with the Science and Art Department are proving the beneficial results of the system. That the Liverpool Town Council has re-established scientific lectures is another evidence of the growing feeling that, in a manufacturing kingdom, science has a real money value.

The want of this knowledge has been most forcibly thrust upon our attention by the cattle plague. It comes upon us, as came the cholera, when we are entirely unprepared to receive it, and our cattle doctors stare at each other in their wretched ignorance, write bald letters to the daily journals, and seek to bury the evidences of their own stupidity in the free use of the poleaxe! In the meantime, the cattle-feeder and the dairyman are left to the tender mercies of the most impudent pretenders. In future years, this period of difficulty will be spoken of as one marking the blind ignorance of a people who boasted of the march of intellect, but who had, in many respects, fallen sadly into the rear. Now that the disease has spread over the length and breadth of the land, men are beginning to study its pathology.

Sanitary science slowly makes itself felt, yet, curiously enough, with the evidence of its advantages in the preservation of health and the improvement of the people which have been brought under its influence, many bodies of men stoutly resist what they are pleased to call its interference. Many of our large towns—especially Liverpool, Glasgow, Manchester, and Leeds—still remain in a most disgraceful state, and villages, singularly picturesque when "distance lends enchantment to the view," are foul and offensive as you approach them. Many of these are now found to be, instead of the homes of health and rosy cheeks, well-devised nurseries of fever. The Social Science meeting of this year drew attention to many of those evils, physical and moral, and the discussions which arose on many of the questions cannot be without their influence for good. No doubt, there are many things comprehended under the singularly expansive title of sanitary science which have little claim to attention, and which serve only to create a smile. Numerous hobbies are ridden with desperate energy on the occasion of these meetings—regarding these, however, as the waste and useless steam blown off, a large reserve of power is left, which can be advantageously applied.

The means of communicating between the guard and the passengers in railway trains has received much attention during the year, but with very slight advantage. On the South-Western Railway an experiment has been fairly tried, with, we believe, evident advantage to all concerned. But railway boards are evidently possessed with the genius of procrastination, and are ever postponing the consideration of improvements, until they are forced upon them by the uncontrollable impetuosity of a public outcry, excited by some frightful accident or other.

To return to the natural sciences, Geology has something to report. It has proved the existence of life in the world during geological ages which have been considered, as it regards organization, a blank, and to which the term of *azoic* (void of life) has been given. Long previous to the origin of the Silurian and Cambrian strata, which were regarded as the oldest sedimentary formations, vast masses of rock had been accumulating in the ancient seas. These have been detected by Sir William Logan in the Laurentian chain of Canada, and by Sir Roderick Murchison in the ancient rocks of the north of Scotland, to which the name of Fundamental Gneiss was given. The Laurentian rocks of Canada contain a zoophyte, the *Eozoon Canadense*, which is certainly the most ancient organization known to exist. The discovery of this Foraminifer in the lowest known deposit confirms the doctrine that the lowest animals alone occur in the earliest zone of life, and that this beginning was followed through long periods by creations of higher and higher animals successively. The evidence is before us, that through the prolonged periods comprehended within the Lower Silurian epoch, no vertebrate animal has been discovered. Fishes begin to appear in the Upper Silurian zone, and they have been continued to the present day. New forms of vertebrate animals have succeeded each other as we ascend in the scale, until in the overlying Secondary and Tertiary formations, higher and higher grades of animals appear, the relics of man or his works having been discovered in the youngest of the Tertiary deposits.

The geologist and the archæologist have here points of contact. The discovery of the rude works of early races of men in drift deposits and in limestone caves, associated with the remains of animals which no longer exist, unmistakably shows the age of man far back in time. This interesting question is not, however, to be regarded as a settled one. Even the best authorities see reasons for holding these hypotheses loosely, hoping that extended researches may clear up many points which now remain obscure or doubtful.

The divisions of a Stone Age and a Bronze Age have been questioned. Mr. Wright is disposed to believe that all bronzes are Roman, and that the use of stone implements and weapons may have been continued, by the untrained tribes inhabiting a country, at the very time when the more cultivated inhabitants of cities were manufacturing both bronze and iron into articles for use or ornament.

The discovery of flint implements in every part of Europe and in the East proves, not as some have supposed, the extension of the same races of men, but rather that pre-historic man, of every race, when he was compelled by his necessities to employ his mind in the production of tools, chose stones at first, as they were most conveniently at hand. The selection of such as were best fitted for cutting instruments, or for delivering a blow, would be the next stage of development.

Geographical Science has been active, and many of our enterprizing travellers have added largely to our knowledge of the Earth's surface. Vâmbéry brings us fresh information from the lands rendered interesting to us all as the scene of the exploits of Timour Khan, and over which travelled our ancient friend Marco Paulo.

The Geographical Society, urged on chiefly by the suggestions of Captain Sherard Osborn, has been occupied with considerations of a new Arctic expedition. Though earnestly advocated by the President and many influential members of the Geographical Society, the question of another expedition has not received any encouragement from the Government, owing, no doubt, to the dangers that beset it, and which have already been fatal to so many brave men. In the meantime, Mr. Hall is dwelling amongst the Esquimaux. He is said to have found Franklin's ships, and he is following up a track which he hopes may lead to more important discoveries

An important work has been carried out through the agency of the officers of our Ordnance Trigonometrical Survey. Sir Henry James, R.E., directed a survey of Jerusalem and of the Dead Sea to be made by Captain Wilson, R.E., and a party of Sappers under him. This has been carefully done, and the true condition of the

Dead Sea relative to the Mediterranean has been set at rest. Much progress has been made towards raising the fund necessary for a complete survey of the Holy Land. It is contemplated, if money enough for the work can be obtained, to place each special subject in the hands of well-known men, and thus ensure the best possible information on the Archeology, Geology, Geography, History, Zoology, Botany, and Meteorology of this interesting region.

In African exploration we have to record the failure of the East African expedition, under Baron C. von der Decken, and that of Du Chaillu in the West. At the same time we have the satisfaction of having Mr. S. W. Baker amongst us, the discoverer of a vast lake, the Albert Nyanza, " a limitless sheet of blue water, sunk low in a vast depression of the country." The western shore, some sixty miles distant from Mr. Baker's place of observation, consisted of a range of mountains, 7,000 feet in height. There is no doubt but that this lake and the Victoria Nyanza of Speke and Grant are the great reservoirs of the Nile.

Of Mr. Palgrave's interesting journeys in Arabia full mention has been made in the Geographical Chronicles of this journal, and we must now in conclusion add a few brief words on the subject of Natural History.

A record of Zoological progress will be found in another portion of this number, and as far as the application of Zoology and Botany to the Arts is concerned, there is but little of interest to be noted. Of the most vital importance to man are the efforts being made, and we are happy to say successfully, to cultivate the Cinchona plant in India. The plantations on the Neilgherries are thriving beyond expectation, and a large supply of quinine may doubtless be looked for from this source. And the successful cultivation of this useful plant in one of our colonies is an unanswerable argument in favour of further researches in all our colonies on the subject of their floras generally. These researches have been pushed forward most vigorously of late by Dr. Grisebach in the British West Indies, by Bentham and Müller in Australia, by Dr. G. Lawson in Canada, and Dr. Hooker in New Zealand. Indeed, if there be one lesson more than another that an enterprizing people should lay to heart, it is that they should not judge hastily which of their colonies are useful, and which are not. The only justification that a nation such as we are, can find for having extended our conquests far and wide, is that it enables our civilizing influence to be felt in savage lands, and our cultivating care in waste places; and it cannot be too strongly urged upon our Government that their first duty abroad is to turn to good account all the products of nature, and to give employment to the intelligent pioneers of every branch of science. Much good has been rendered to Zoological science by Mr. H. B. Tristram, who has made an extensive collection of animals in Palestine, which have afforded work for some of our leading zoologists at home; indeed, it seems surprising that the fauna of a country rendered so interesting by tradition should have been so little known in Great Britain.

And now the mention of Zoology and tradition will, no doubt, have suggested to many of our readers that delicate problem, the Origin of Species, and consequently the Origin of Man. Although to the unscientific world it may appear that the whole question slumbers, this is far from being the case. Day by day new evidence is adduced either for or against the theory of natural selection and the transmutation of species; and surely, but silently, a revolution is taking place in the method of recording natural history.

That silence we shall not at present attempt to break; for it is as essential to the progress of knowledge and to the attainment of truth as are the hidden processes which are going on in the secret places of nature, or in the closed workshops of art, before the new life can be revealed, or the finished work exhibited. But we feel bound to say a few words concerning some of the means now adopted to attempt the elucidation of the most interesting and difficult problem of the day—namely, the origin and development of man. We have at the present time in London two competing societies, publishing two competing journals, both of which, under different titles—the 'Ethnological' and the 'Anthropological'—profess themselves anxious to throw light upon this obscure and warmly-debated subject. A glance at the proceedings of these two societies would lead the unprejudiced observer to form rather a humble estimate of the efforts of science in this direction, for it is hardly possible to be present at their meetings, or to peruse a Number of the respective journals, without at once perceiving that one of the most serious and important scientific questions of the day is being treated, to speak mildly, in a sensational rather than a rational and legitimate manner. Whichever way we turn, we are met by personal recrimination, bad puns, exhibitions of vanity, and anything but the evidences that man is a reflecting, reasoning creature. We are not going to condemn utterly either the Anthropological or the Ethnological Society. To judge from the account given in the 'Ethnological Journal' of the establishment of the 'Anthropological,' we feel convinced, although the writer of the article thinks otherwise, that a new society was to some extent a necessity of the "situation;" but when we turn to the 'Anthropological Journal,' or consider the mode in which its officers seek to attract public attention, we find with regret that the need has not been supplied in a manner worthy of this great nation. Just imagine two large societies, reckoning amongst their members some of the leading investigators of the day, established for the purpose of elucidating their own human nature and the history of their race, calling each other names, and squabbling like a couple of schoolboys whether this or that one has a right to say aloud the lesson which both are just beginning to learn!

There is ample room for both societies to investigate the origin and nature of man, and other germane subjects, and we should not be surprised to see established, before long, a third society, which would certainly succeed if it sought to combine the modest, moderate, and self-sacrificing men of both parties.

What appears to us to be needed for the elucidation of the subject, is not a medley of desultory papers on the negro, cannibalism, anthropology, philology, and so forth, but a well-devised programme or scheme, somewhat of the nature of a commission, which shall bring together all relevant facts; sift and prune, suggest and search; until we shall have presented to us, an uncoloured and accurate, though it may be at present an imperfect outline of the rise, development, and present condition of the human race throughout the world. There are men of science living who are well qualified to co-operate in such a labour, but for the reasons already assigned, they hold aloof from the controversy, and are content to wait for the return of calm judgment and courtesy into the councils of anthropological or ethnological science.

A new year now dawns upon us, a year that may be barren of incident, or pregnant with important revelations, and one that will assuredly be too short for every earnest student of Science; for all who seek to place her in her legitimate rank in civilization and religion.

Let us, then, not wrangle about words, nor seek to elbow our way into a higher seat than our neighbours, lest we find ourselves in the lowest seat of all; but giving without stint of the knowledge that is so freely given to us, let us diligently and hopefully continue our search after Truth.

Quarterly List of Publications received for Review.

1. Introduction to Modern Chemistry, Experimental and Theoretic. Embodying Twelve Lectures delivered in the Royal College of Chemistry, London. By A. W. Hofmann, LL.D., F.R.S., V.P.C.S., Professor of Chemistry in the Royal School of Mines, &c. &c. 65 *Woodcuts.* 250 pp. Post 8vo. *Walton & Maberly.*

2. On the Combining Power of Atoms. By A. W. Hofmann, LL.D., F.R.S. 30 pp. Demy 8vo. *From the Author.*

3. The Record of Zoological Literature. 1864. Vol. I. Edited by Dr. Günther, M.A., F.Z.S., &c. 640 pp. Demy 8vo. *Van Voorst.*

4. Treatise on Iron Ship-building: its History and Progress, as comprised in a Series of Experimental Researches on the Laws of Strain; the Strengths, Forms, and other Conditions of the Material; and an Inquiry into the Present and Prospective State of the Navy, including the Experimental Results on the Resisting Powers of Armour Plates and Shot at high Velocities. By Wm. Fairbairn, C.E., LL.D., F.R.S. With 126 *Engravings.* 350 pp. Demy 8vo. *Longman & Co.*

5. On some Physical Effects produced by the Contact of a Hydrogen Flame with various Bodies. By W. F. Barrett, Assistant in the Physical Laboratory of the Royal Institution. 9 pp. 8vo. *From the Author.*

6. Researches on Solar Physics. By Warren De la Rue, Ph.D., F.R.S., Balfour Stewart, F.R.S., Superintendent of the Kew Observatory, and Benjamin Loewy, Observer and Computer to the Kew Observatory. First Series. On the Nature of Sun-spots. 33 pp. Royal 4to. *From the Authors.*

7. Handbook of Geological Terms. Geology and Physical Geography. By David Page, F.R.S.E., F.G.S. Second edition. 500 pp. Crown 8vo. *Blackwood & Sons.*

8. On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life. By Charles Darwin, M.A., F.R.S. Third edition. 550 pp. Post 8vo. *John Murray.*

9. On the various Contrivances by which British and Foreign Orchids are fertilized by Insects, and on the good Effects of Intercrossing. By Charles Darwin, M.A., F.R.S. *With 34 Wood-engravings.* 370 pp. Post 8vo. *John Murray.*

10. Journal of Researches into the Natural History and Geology of the Countries visited during the Voyage of H.M.S. 'Beagle' round the World. By Charles Darwin, M.A., F.R.S. Tenth thousand. 530 pp. Post 8vo. *John Murray.*

11. On the Movements and Habits of Climbing Plants. By Charles Darwin, F.R.S., F.L.S. 1865. Taylor & Francis. *From the Author.*

12. Report of the United States Patent Office for 1862. 2 vols. Vol. I. Text; Vol. II. Plates. *Washington Government Printing Office.*

13. Contributions to Blowpipe Analysis. By E. J. Chapman, Ph D., Professor of Mineralogy and Geology in University College, Toronto. 20 pp. Demy 8vo. *From the Author.*

14. Cholera Prospects; compiled from Personal Observation in the East, for the Information and Guidance of Individuals and Governments. By Tilbury Fox, M.D. Lond. 40 pp. Demy 8vo. *Hardwicke.*

15. A Treatise on Smoky Chimneys, their Cure and Prevention. By Frederick Edwards, jun. Second Edition, *with Plates.* 40 pp. Demy 8vo. *R. Hardwicke.*

16. Our Domestic Fireplaces; a Treatise on the Economical Use of Fuel and the Prevention of Smoke; with Observations on the Patent Laws. By Frederick Edwards, jun. Second Edition, *with Plates.* 110 pp. Royal 8vo. *R. Hardwicke.*

17. Inorganic Chemistry for Science Classes. By Fearnside Hudson, F.C.S., Government Certificated Science Master, Manchester. 200 pp. Crown 8vo. *From the Author.*

18. Seven Lectures on Scripture and Science. By John Eliot Howard, F.L.S. 240 pp. Crown 8vo. *Groombridge & Sons.*

19. Catalogue of Works on the Microscope and of those referring to Microscopical Subjects in the Library of Freeman C. S. Roper, F.L.S., F.G.S., F.Z.S., &c. Printed for private circulation. *Adlard,* 1865.

PAMPHLETS.

On Chemical Reactions obtained by employing Anhydrous Liquids as Solvents, By G. Gore, F.R.S.

Proceedings of the British Pharmaceutical Conference. Birmingham Meeting, 1865. 90 pp. Demy 8vo. *From the Conference.*

Bulletin Mensuel de la Société Impériale Zoologique d'Acclimatation. Aug., Sept., Oct. *Masson & Fils.*

Rinderpest, its Prevention and Cure; and Gypsum as a Sanitary Agent. *Edinburgh: W. P. Nimmo.*

Revue Universelle des Mines, de la Métallurgie, &c. *Paris and Liege: Noblet & Baudry.*

A Dictionary of Science, Literature, and Art. Edited by W. T. Brande, D.C.L., F.R.S., and the Rev. Geo. W. Cox, M.A. Parts VI., VII., VIII. *Longmans & Co.*

Geological Magazine: Oct., Nov., Dec. *Longmans & Co.*

The Production and Preservation of Lakes by Ice Action. By Thomas Belt. 8 pp. Demy 8vo. *From the Author.*

Westminster Review: October. *Trübner & Co.*

Report of the Health of Liverpool. Sept. 2, 1865. By W. S. Trench, M.D., Medical Officer of Health, Liverpool.

Canadian Naturalist and Geologist: August. *Montreal: Dawson Brothers.*

Scientific Review: Nov. and Dec. *Cassell, Petter, & Galpin.*

Ethnological Journal: October, November. *Trübner & Co.*

Proceedings of the Royal Society.
" " Royal Astronomical Society.
" " Royal Geographical Society.
" " Chemical Society of London.
" " Geological Society of London.
" " Zoological Society of London.

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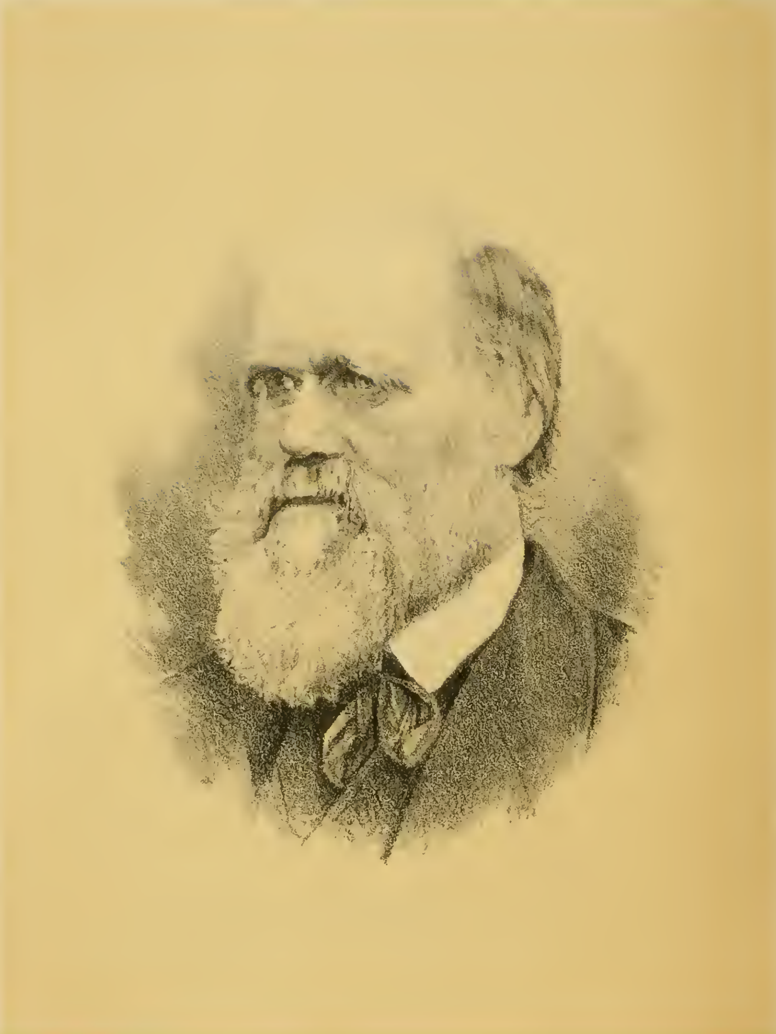

Vincent Brooks, del. et lith.

Charles Darwin
1866.

THE QUARTERLY

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APRIL, 1866.

I. DARWIN AND HIS TEACHINGS.

(Illustrated.)

It may seem strange to many thinking men, and to posterity it will doubtless appear inexplicable, that at this era in his history Man should still be obliged to approach with hesitation and reserve a subject so matter-of-fact as the Origin of Species, and that the publication of his views concerning his own animal nature and origin should always be accompanied by grave misgivings. But when we remember how few there are who can dissociate such inquiries from their religious creed, and with what reluctance such persons venture upon investigations that might have a tendency to shake the faith in which they have been educated; when we consider that many professors of theology conceive it to be their duty to foster these misgivings on the part of their "flocks," and to denounce men of science as instruments of the Evil one; then indeed it is not surprising that great courage should be needed for the exercise of unfettered thought and for the expression of what may be regarded as heterodox opinions. These checks upon the intellectual development of the human race, and this slow growth of free inquiry, are not, however, entirely without their advantages, nay, paradoxical as it may seem, they are in some degree essential to the steady progress of truth. The wisest men frequently err, and there are many who would have been thankful if an unfriendly critic had nipped some well-matured theory in the bud; the enterprising and impetuous reformer stands in greatest need of controlling agencies and adverse judgments; and the masses would remain stagnant and uninfluenced by men of thought and observation if these were continually pushing onward heedless of the difficulties and disdaining the shortcomings of the multitudes, whom they should seek to lead, and not to drive along the tortuous and thorny paths of discovery. Nothing, indeed, would be more unfortunate than if, at the present day, when man's thoughts outstrip his power of locomotion, there should be too great leniency in the judgment of new dogmas, for there would soon be a transition from liberty to licence, which would inevitably be succeeded by a reaction fatal to progress. It appears wholly unnecessary to seek examples of the truth of these propositions, for who that will be at the trouble of thinking over the names of men conspicuous for their attainments in any department of human knowledge, in science, politics, or literature, can fail to alight upon numerous apt illustrations; but nowhere, we think, could a more perfect exemplification of what has here been advanced be found, than in the publication, reception, and influence of the teachings of Charles Darwin.

In one place we find the author and his theories vehemently denounced as subversive of all religious and moral truth; in another, he is held up as the founder of a new faith, and is almost deified by men who can see in nature nothing but a self-acting machine, whilst in Darwin, who is an apt student of nature, they manage to perceive a master-mind!

It has been chiefly urged against his theory of "Natural Selection," by persons otherwise disposed to adopt his Zoological doctrine, that he attributes too much to "Nature," and too little to God. "It has been said," he himself remarks,* "that I speak of natural selection as an active power or Deity, but who objects to an author speaking of the attraction of gravity as ruling the movements of the planets? Everyone knows what is meant and implied by such metaphorical expressions; and they are almost necessary for brevity." But this and other explanations or justifications which appear in the later, but not in the early editions of his master-work,† do not seem to remove what is decidedly the objectionable portion of his theory, nor to strengthen its weak points. We are not now speaking of the religious or irreligious tendency of the omission, but simply of the defect in his biological dogma, for, as we shall endeavour to show, "Natural Selection" is of itself not sufficient to explain the phenomena, past and present, of nature. Or, lest we should be met on the threshold of our inquiry by the objection that the illustrious naturalist does not claim for "Natural Selection" any such power, let us rather say that all the causes denoted by him, whether clearly, or (as it appears to us in some cases) ambiguously, are insufficient to produce even the phenomena included by him within the limits of his law, much less to accomplish those results which some of his disciples have justly stated, must follow as a matter of course from its admission, although he studiously avoids their nearer observation or discussion.

In these and other remarks upon Darwin's views, let it be clearly

* 'Origin of Species,' p. 85. (Murray.) Unless otherwise stated, our references will always be to the third edition, 1861.

† Compare, for example, 'Origin of Species,' first edition, p. 81, with third edition, pp. 84 and 85, where a paragraph is inserted; also, first edition, p. 83, with third edition, p. 87, where "natural selection" is substituted for "nature."

understood that we have no ambition to be reckoned among his censors; but whilst we admit his right of free speech, and applaud his fearless exercise of it, we feel quite justified, without rendering ourselves subject to the imputation of disrespect towards a great thinker and (judging from his works) a good man, in handling his dogmas without ceremony or reservation.

Whilst it is impossible not to perceive in his writings the dictates of a heart naturally reverential towards God and full of sympathy for his fellow-men,* there can be no doubt that the general body of his readers, whether lay or clerical, scientific or popular, must necessarily have received the impression that he endeavours to force the Deity out of sight, and to endow "Natural Selection" with Omnipotence and Omniscience. Take, for example, the following sentences from among many similar ones, which may be found even in the later and corrected edition of his work on the 'Origin of Species:'

"As man can produce, and certainly has produced a great result by his methodical and unconscious means of Selection, what may not *Natural Selection* effect? Man can act only on external and visible characters; Nature (*if I may be allowed thus to personify the natural preservation of varying and favoured individuals during the struggle for existence*) cares nothing for appearances, except in so far as they are useful to any being. She can act on every internal organ, on every shade of constitutional difference, on the whole machinery of life. Man selects only for his own good—Nature only for that of the being which she tends. Every selected character is fully exercised by her, and the being is placed under well-suited conditions of life."†

In the earlier editions, the word "Nature" stood for "Natural Selection," underlined in the foregoing extract, and the italicised sentence, intended to be explanatory of the latter term, was omitted altogether. Here, and in many other parts of his work, where the desire for "brevity" cannot be pleaded as an excuse, the author manifestly endows "Nature" with the intelligent faculty of designing and planning, and when it is remembered how rapidly (often indeed too rapidly) public criticism now follows the publication of new works; how these are *devoured* on their first appearance by literary gourmands before they can be carefully digested by experienced and thoughtful men of science, it will be clear that the new doctrine of Darwin must have borne with it an element far more antagonistic to its own universal acceptance than any that have since been associated with it by the more impetuous and indiscreet of

* See his 'Naturalist's Voyage round the World' (tenth edition, Murray, 1860), pp. 158, 500, 503; 'Origin of Species,' pp. 515, 525; 'On the Contrivances by which British and Foreign Orchids are Fertilized by Insects' (Murray), p. 2.

† 'Origin of Species,' p. 87.

his disciples, or than any obstacles that literary conservatism or sectarian intolerance may have thrown across its path.

And this is, indeed, much to be regretted on many grounds, not the least important being, that at the time when his views on the "Origin of Species" were first promulgated, the state of the public mind rendered great caution advisable in the publication of physical theories apparently opposed to religious tradition. The pruning-knife had been very ruthlessly applied to the tree of knowledge during the few years previous to the appearance of Darwin's book, and we know how at least one noble mind sank under the pressure of dogmas at variance with his previous theological beliefs. True, the large majority of thinking men, first savans, next laymen, and finally clergymen, had become reconciled to the new light which shone upon a world, now admitted to have been in existence ages of ages instead of a few thousand years, and the period of man's advent had also been removed to an earlier date than that assigned to it by tradition; but there were millions whose minds were still encrusted with the old doctrine, and thousands ready to seize upon any indiscretion on the part of natural philosophers, and to strangle the new-born infant of Science at its birth. But whilst all those facts which led to the revolution in men's minds concerning the six days' creation were clearly engraved upon the works of nature, and carried conviction to all who chose to observe and reflect, there is undeniably mixed up with the new law, or we should say, the recently revived doctrine of the transition of species a sufficiently large amount of speculation to preclude its acceptance otherwise than as a well-founded hypothesis. Many able men who have relinquished the biblical version of the creation, still, consciously or unconsciously, take their biological and zoological doctrines from the sacred writings, and some of these contend that the words "after his kind," and "after their kind," which so frequently occur in the first chapter of Genesis, mean the special creation, by a supernatural or miraculous intervention of the Almighty, of each new species, and of course to such reasoners there is no difficulty in accounting for the origin of man in conformity with the traditional account of his creation. Others, again, who are opposed to Darwin's views, do not base their opposition upon Scripture alone, but they say, and truly, that no new species has ever been known to come into existence either by natural or by artificial selection within the historic period, notwithstanding that experimentalists have, with one purpose or another, succeeded in breeding or producing innumerable widely divergent *varieties* of existing species.

But although the twofold nature of the argument against Darwin's views has told heavily against their acceptance, we believe reflecting men will soon find that the opposition on theological grounds cannot hold its place, and that it resembles in its character all the preceding cases of antagonism to innovations of a like nature; indeed, it would be idle to conceal the fact, that Darwin already reckons amongst his disciples many scientific clergymen and ministers of the different religious denominations. The scriptural account of the creation of plants and animals presents as many difficulties one way as the other. The *literal* translation of Genesis i. 2, runs thus—"And God said, the earth shall sprout forth sprouts, herb yielding seed, fruit-tree yielding fruit after its kind, whose seed (is) in itself, upon the earth; and it was so." And of v. 20, thus—"And God said, the waters shall bring forth abundantly the prolific creation, a living soul, and fowl (that) may fly above the earth on the face of the expanse of heaven."*

Excepting for those who still believe in the doctrine that all plants and animals took their rise at one time, when the command was given, and were created in two days, we cannot conceive how this account can be held to convey any scientific exposition of the mode in which species were produced. We may be in error, but it does not appear to us to affirm more than the grand truth—that the Almighty created plants and animals, and that the former contained seeds "after their kind," or for their propagation; and (naturally enough when we consider to what class of minds it was addressed) it does not even hint at the mode in which animals were to be perpetuated. If, however, the reference to the earth and waters bringing forth plants and animals, presents any special evidence on the subject, it is rather in favour of their production through secondary agencies, than by a direct miraculous interposition for the purpose of making species. But suppose the account is meant to indicate (which, however, we do not for a moment believe) that all species were created as they stood or moved, by one grand miracle, how are we to explain the subsequent production of varieties by "nature" or by man? Those who hold the "orthodox" view must supplement it by an original doctrine of their own, and must believe that after having created species Himself by miraculous intervention, the Almighty must have deputed "Nature" and man to make varieties; or if (as we are fully convinced is the case) He has been as directly instrumental in the production of varieties as in that of species, what becomes of the miraculous creation of the former? As far, then, as the abstract theological bearing of the question is concerned, it becomes, as in most similar cases, a matter of individual opinion; but, on the other hand, it will be found presently, that if we were to admit the entire correctness of Darwin's theory, as expounded by himself, we should find ourselves involved in difficulties quite as grave and perplexing as those presented by the miraculous version, and we will now direct our attention more immediately to his teachings.

* Dr. A. Benisch's 'Translation of the Pentateuch.'

Before the publication of his views, the large majority of naturalists believed that "species" were distinct creations, chiefly on the ground that, when crossed, they are unable to produce fertile offspring; but that varieties which are fertile when crossed, are the modified descendants of species by generation. A considerable minority, who saw the difficulty of defining the limits of species and varieties, felt convinced that both are modified descendants of preceding species—in fact, that there has been a gradual progression from lower to higher forms of life, and that the terms "variety," "species," "genus," "family," &c., however convenient for classificatory purposes, are arbitrary designations invented by Man, and have no actual existence in Nature.

But then the question arose—how were these modifications brought about? It is true that many species were found to be very closely allied in their external characters through intermediate living varieties, or through fossil representatives; but the existence of those did not suffice to account for the change from one species to another, for it was a well-established fact that whilst there seemed to be hardly any limit to the production of fertile varieties, as soon as it was attempted to cross two species, either they refused to breed or they produced an infertile offspring. Many and ingenious were the theories of progression or transmutation propounded by various authors, either openly or anonymously, as in the case of the 'Vestiges of Creation;' but the doctrine which presented the most philosophical aspect was that of Lamarck, the celebrated French naturalist, who, about fifty or sixty years since, enunciated the theory that the different types of animals became modified during the ordinary succession of generations through the influence of their desires and wants, which compelled them to exercise certain organs and members in such a manner as to induce an extension, growth, or development of those organs in preponderance over others.* Lamarck also believed in an unknown law of progressive development. At first, his theory took naturalists by surprise, but it soon appeared to assume a somewhat ludicrous character, for it seemed absurd to suppose that by any such process of modification the neck of a deer-like animal should have been stretched to that of a giraffe, or the snout of a tapir into the trunk of an elephant; just as we find persons in the present day who laugh at Darwin's theory, as they cannot conceive it possible that some lovely companion, or intellectual savant, to whom they are showing a stuffed gorilla, should be the descendant, however remote, of so hideous an animal as stands before them. It must be remembered, however that since Lamarck published his views, many fossil types interme-

* The best reference on this subject will be found in Darwin's 'Historical Sketch of the Recent Progress of Opinion on the Origin of Species,' p. 13, 3rd edit.

diate between allied recent ones, have been found which, had they been known at that time, would, to a great extent, have removed these difficulties, and would probably have secured a larger share of popularity for his doctrine.

But what appears the strangest of all is that it has been the fashion of late with some of the disciples of Darwin, in their zeal for the establishment of his theory, to decry or under-estimate the value of Lamarck's doctrine. Not so with the illustrious naturalist himself, as any one may find, who refers to his introduction to the third edition of his 'Origin of Species;' and we think he has exhibited a sound judgment in giving full credit to the labours of his eminent predecessor. One of his most ardent admirers, however, Professor Huxley, told the working classes of London, shortly after Darwin's great work had appeared, that "when people tell them that Mr. Darwin's strongly-based hypothesis is nothing but a mere modification of Lamarck's, they would know what to think of their capacity for forming a judgment on the subject."*

Why the eminent physiologist in question should thus visit with his denunciations those who venture to differ from him on this interesting and obscure subject, we are at a loss to understand; but we cannot help admitting that we are guilty of this indiscretion. In several portions of Darwin's work, especially in his paragraphs on 'The Effects of Use and Disuse' (first edition, p. 134—third edition, p. 151), we cannot help seeing a resuscitation of Lamarck's doctrine; and as to his 'Law of Progressive Development,' it appears to us about the same as Darwin's 'Law of Variation;' and a more legitimate mode of expressing a mysterious influence than Professor Huxley's 'Tendency to Variation.' "The tendency to reproduce the original stock," says Mr. Huxley, "has, as it were, its limits; and side by side with it, there is a tendency to vary in certain directions, as if there were two opposing powers working upon the organic being—one tending to take it in a straight line, the other tending to make it diverge from that straight line first to one side and then to another."† And again, "This tendency to variation is less marked in that mode of propagation which takes place asexually; it is in that mode that the minor characters of animal and vegetable structures are most completely preserved."‡

No one who reflects upon these observations, and the phenomena of conjugation, generally, can fail to be less strongly impressed with its mysterious influences than were Lamarck, Darwin, Professor Huxley, and others; and yet men either deny the constant operation of the Deity, or are seeking in the past for miracles to glorify him, whilst they fail to perceive them in the results of those generative processes with which they have become familiarized

* 'Lectures to the Working Men' (Hardwicke), p. 150.
† Ibid., p. 89. ‡ Ibid., p. 89.

through their every-day occurrence, and whose effect in the modification of species has never yet been properly considered.

Notwithstanding that the doctrine of "progressive development" was (and for that matter is still, by many thoughtless persons) branded as atheistical, and although it had been supported only by the imperfect observation of a few biologists, and the still more imperfect records of nature, it had been gaining ground rapidly for some time before Darwin ventured to revive it, endorsed by the results of an extensive experience, a long-continued course of study and reflection, and the honest convictions of a sincere lover of truth. Darwin was no apprentice in science when he gave publicity to his views. In the winter of 1831, when he had attained his twenty-second year, having been educated and taken his B.A. degree at Christ's College, Cambridge, he volunteered his gratuitous services as naturalist on board of H.M. surveying ship 'Beagle,' Captain Fitzroy, R.N., and made a voyage, or it would be more correct to say a continuous series of voyages, in that vessel to Bahia, thence to Rio Janeiro, Monte Video, Ports Desire, St. Julian, and Santa Cruz; the Falkland Islands, Terra del Fuego, Valparaiso, Chilöe, Lima, some of the islands of the South Pacific, New Zealand, Sydney, Van Dieman's Land, Mauritius, St. Helena, Bahia, Pernambuco, and back to England, where he arrived on the 2nd October, 1836, having been absent nearly five years, and making various exploring expeditions along the coast, into the interior or to the islands adjacent to the ports where the 'Beagle' stopped. As ten thousand copies of the Journal of his researches during the lengthy voyage had been printed in 1860, we may safely infer that most of our readers are well acquainted with the contents of the volume, and few will be disposed to deny it the merit of being one of the most charming and attractive books of travel ever given to the world. But irrespective of its undoubted merit in this regard, and irrespective, too, of its value as a record of the scientific and social history of the lands and peoples visited by the illustrious naturalist, it now possesses a fresh value, inasmuch as its re-perusal, after the study of his book on the 'Origin of Species,' materially aids the inquirer in arriving at a correct estimate of the value of his new biological doctrine. Whilst we find in the 'Journal' that vast store of information which served as the starting-point for his further researches and the basis of many of his subsequent arguments, we cannot help being struck with the fact that his views must have undergone great modification between the time of his arrival in England in 1836 and the first publication of his great work on Species in 1859. When he wrote or published the 'Journal,' in 1845, he could hardly be regarded as a very staunch believer in the progressive theory; we are justified in coming to this conclusion by the opening remarks in his 'Origin of Species,' where he tells us that during his voyage "certain facts in the distribution of the inhabitants of South America," &c., &c., "seemed to throw some light on the origin of species." Strangely enough, even as late as 1860, we find in his 'Journal of Researches'* the following expression concerning his predecessor: "Lamarck would have been delighted with this fact, had he known it, when speculating (probably with more truth than usual with him) on the gradually-acquired blindness of the aspalax—a gnawer, living underground, and of the proteus, a reptile living in dark caverns filled with water;" whilst in the introduction to his new edition of the 'Origin of Species,' published the following year, he speaks of Lamarck and his theory in such terms as would lead the general reader to suppose that he regards them with the highest admiration. Moreover, although the theories enunciated in his 'Origin of Species' are foreshadowed in his 'Journal,'† we cannot anywhere find a decided expression of opinion as to the origin of species by descent, although there seems to be a kind of vague idea pervading the whole work, that new species must have originated through some such process. This piece of evidence is of itself valuable to a student seeking to measure the mind of an author who propounds a doctrine widely at variance with popular views, for the published opinions of such a man, in fact, his whole *public* character necessarily guide the investigator in forming an estimate of his doctrines. Darwin's 'Journal' shows him to have possessed at that time traits which peculiarly adapted him to enter upon such an inquiry as he subsequently undertook. From his 'Journal,' he appeared naïve and truthful, thoroughly alive to the value and influence of religion,‡ a wonderfully close observer of every phenomenon, whether in natural history or social life and customs. His reasoning on the phenomena of nature—as, for example, with regard to the origin of coral reefs—is irresistible; he seems to weigh carefully everything that he or anyone else has observed before taking a single step in advance and to repeat his observations before he takes another. And through all his reasoning there appears to be no want of confidence in his readers. "Think for yourselves," he seems to say, "but I feel pretty confident my way of thinking will be yours." In fact, on reading his 'Journal,' one seems to travel with him; his graphic descriptions of men and countries, extreme and startling as they often are, never awaken a doubt, and he has no need of

* 'Journal of Researches into the Natural History and Geology of the Countries visited during the Voyage of H.M.S. "Beagle" round the World.' Tenth thousand. Murray, 1860. P. 52.

† See 'Journal of Researches,' 1860, pp. 131 and 132, 145 to 147, 173 to 176, 327, 377, *et seq.*; and especially as to the "struggle for existence," p. 435, beginning at line 1.

‡ Ibid., p. 300, beginning "With no particular zeal for religion," &c., p. 428, second and third par.; p. 430, "Neither is the country itself attractive. I look back but to one bright spot, and that is Waimate, with its Christian inhabitants."

photographs beyond those of his pen, nor of any witnesses besides himself.

And there are certain phenomena connected with the nature of the lower animals and of man which appear at that time to have made a remarkable impression upon the young traveller. One of these was the "tendency to variation," by slow degrees, in some species. Speaking, for example, of a certain venomous snake in Patagonia, a Trigonocephalus, he says—

"Cuvier, in opposition to some other naturalists, makes this a subgenus of the rattlesnake, and intermediate between it and the viper. In confirmation of this opinion I observed a fact, which appears to me very curious and instructive, as showing how every character, even though it may be in some degree independent of structure, has a tendency to vary by slow degrees. The extremity of the tail of this snake is terminated by a point which is slightly enlarged, and as the animal glides along it constantly vibrates the last inch, and this part striking against the dry grass and brushwood produces a rattling noise, which can be distinctly heard at the distance of six feet. As often as the animal was irritated or surprised, its tail was shaken, and the vibrations were extremely rapid. Even as long as the body retained its irritability a tendency to this habitual movement was evident. This Trigonocephalus has, therefore, in some respects, the structure of a viper, with the habits of a rattlesnake; the noise, however, being produced by a simpler device."*

Another phenomenon, illustrating in a conspicuous manner his subsequent law concerning the preservation of favoured races and the extinction of others,—a most important feature in his theory of natural selection,—presented itself to his notice during his stay in Banda Oriental. It was connected with a peculiar breed of cattle in that country, and we will extract his account of it:—

"Don F. Muniz, of Luxan, has kindly collected for me all the information he could respecting this breed. From his account it seems that about eighty or ninety years ago they were rare, and kept as curiosities at Buenos Ayres. The breed is universally believed to have originated amongst the Indians southward of the Plata; and it was with them the commonest kind. Even to this day, those reared in the provinces near the Plata show their less civilized origin, in being fiercer than common cattle, and in the cow easily deserting her first calf if visited too often, or molested. It is a singular fact, that an almost similar structure to the abnormal one of the niata breed, characterizes, as I am informed by Dr. Falconer, that great extinct ruminant of India, the Sivatherium. The breed is very true, and a niata bull and cow invariably produce niata calves. A niata bull with a common cow, or the reverse cross, produces offsprings having an intermediate character, but with the niata characters strongly displayed. According to Señor Muniz, there is the clearest evidence, contrary to

* 'Journal of Researches,' pp. 96–7.

the common belief of agriculturists in analogous cases, that the niata cow when crossed with a common bull, transmits her peculiarities more strongly than the niata bull when crossed with a common cow. When the pasture is tolerably long, the niata cattle feed with the tongue and palate as well as common cattle; but during the great droughts, when so many animals perish, the niata breed is under a great disadvantage, and would be exterminated if not attended to; for the common cattle, like horses, are able just to keep alive, by browsing with their lips on twigs of trees and reeds; this the niatas cannot so well do, as their lips do not join, and hence they are found to perish before the common cattle. This strikes me as a good illustration of how little we are able to judge, from the ordinary habits of life, on what circumstances, occurring only at long intervals, the rarity or extinction of a species may be determined."*

We have extracted these two paragraphs at length, from his 'Journal,' to show that more than twenty-five years before the appearance of his great work on the 'Origin of Species,' Darwin's attention had been directed to, or, we should say, arrested by phenomena similar to those which he imported into that work in which we find no mention of either phenomenon although both would well have served to aid him in proving his theory; and we believe our zoological readers will agree with us that facts stated so unpremeditatedly are far more valuable than others selected by the author for the purpose of proving a point. Again, our readers will find, if they take the trouble to refer to his 'Journal,' that it contains much valuable information bearing upon the changes which have been effected in animals through migration, for throughout there are repeated evidences of variation in structure and habit being favoured by this cause.

One striking instance of this unconscious accumulation of evidence in favour of his subsequent convictions and, at the same time (if we rightly interpret his meaning), of his unbelief at that time in the transmutation theory, will be found in his account of the variation of species on either side of the Cordillera.† He shows that the species on the two opposite sides of this range are distinct but allied, although the climate, soil, and longitude and latitude may vary but little, and he attributes this variation to the barrier thus opposed to the migration of all but a few animals. In a note he says:—"This is merely an illustration of the admirable laws first laid down by Mr. Lyell, on the geographical distribution of animals as influenced by geological changes. The whole reasoning, of course, is founded on the assumption of the immutability of species, otherwise, the difference in the species in the two regions might be considered as superinduced during a length of time."

Of course, in his new doctrine, he does believe that the

* 'Journal of Researches,' pp. 146–7. † Ibid., pp. 326–7.

difference in species is superinduced "during a length of time;" and if we turn to his later work, we find that "neither the similarity nor dissimilarity of the inhabitants of various regions can be accounted for by their climatal and other physical conditions,"* but *that barriers of any kind*, or obstacles to free migration are related in a close and important manner to the differences between the productions of various regions.† He exemplifies this law by showing that whilst there is a very slow and gradual variation of species as one travels north and south on the continent of South America, the land barrier of the Andes causes us to find *abrupt* changes in species on the opposite sides of those mountains, though the actual longitudinal distance between the two regions may be small. Thus he seeks to prove that, in both cases, *time*, and not miracle, has been the cause of the change in species, either in permitting migration to regions with different physical conditions, or in raising a barrier which impeded migration and so left the inhabitants nearly but not immediately allied.

But if we find in the 'Journal of Researches' a very large store of information, which might have been successfully employed, had the author been so minded, in the establishment of his later theories, we cannot help being struck by the significant fact that there are many data which we should naturally have expected to find in his 'Origin of Species,' if his theory were founded on a sound and immutable basis. The young naturalist was not content to observe living plants and animals, rocks and fossils, but he directed a large share of his attention to men and manners, and had the opportunity so rarely afforded to naturalists of seeing, side by side, the very lowest and the highest types of mankind; and yet, to quote the words of one of his most enthusiastic and eminent disciples, "Mr. Darwin has said nothing about man in his book;" but, "if Mr. Darwin's views are sound, they apply as much to man as to the lower animals."‡

Now it is a circumstance which has more than once come under our own observation, that persons who have traded on the west coast of Africa, and have come into contact with the savages there (although the latter have, to some extent, enjoyed the advantages of European intercourse), have been almost irresistibly led to embrace Darwin's views, on the ground that the untutored beings whose habits they have been compelled to observe approximate so closely to the brutes. But the great naturalist has witnessed even more striking contrasts than they, and yet practically he is silent as to the origin of man.

* 'Origin of Species,' p. 376. † Ibid., p. 376.

‡ Professor Huxley: 'Lectures to Working Men.' It is, however, only fair to Darwin to add that this must not be taken literally, for he does say that he expects to see light thrown on the origin and history of man, should his theory be confirmed.—'Origin of Species,' 1st edition, p. 489, l. 3 and 4; 3rd edition, p. 523, l. 33, 34.

In Tierra del Fuego, he says he saw the most abject and miserable creatures he anywhere beheld.* On one occasion, all the men and women were naked, and the rain was pouring down upon them; on another, a woman, suckling an infant, "came alongside the vessel, and remained there, out of mere curiosity, while the sleet fell and thawed on her naked bosom, and on the skin of her naked baby." These poor creatures were "stunted in their growth, their hideous faces bedaubed with white paint, their skins filthy and greasy, their hair entangled, their voices discordant, and their gestures violent." Their wants and habits of life needed no faculties higher than those of an ape;† their capacity for improvement stood at zero; their language "scarcely deserves to be called articulate," and "certainly no European ever cleared his throat with so many hoarse, guttural, and clicking sounds:‡—

"One's mind hurries back over past centuries, and then asks, could our progenitors have been men like these? men whose very signs and expressions are less intelligible to us than those of the domesticated animals; men who do not possess the instinct of those animals,§ nor yet appear to boast of human reason, or at least of arts consequent on that reason, ... and part of the interest in beholding a savage is the same which would lead every one to desire to see the lion in his desert, the tiger tearing his prey in the jungle, or the rhinoceros wandering over the wild plains of Africa."‖

We are compelled to curtail this, and to omit many other passages of a like tenor, but have we not quoted enough to justify our surprise that, notwithstanding the revelations of bone-caves and of the drift, which prove that our progenitors have been "men like these,"¶ the ablest living exponent of the transmutation theory, and the founder of the doctrine of natural selection, should never so much as refer, directly or indirectly, to the origin of man?

Of course our readers are nearly all aware of the nature of that doctrine. His work on the 'Origin of Species' was published towards the end of the year 1859, about twenty years after the first appearance of his 'Journal of Researches,' the author having, in the interim, conferred great services upon the scientific world by his later treatises on the 'Voyage of the Beagle,' on 'The Structure and Distribution of Coral Reefs,' 'Geological Observations on Volcanic Islands,' 'Geological Observations on South America,' and other minor publications; indeed, he had already raised himself

* 'Journal of Researches,' p. 213. † Ibid., p. 216, par. 1.

‡ Ibid., pp. 205–6, last and first paragraphs.

§ He gives examples of unfeeling brutality towards their offspring of which animals are not capable.

‖ 'Journal of Researches,' p. 504.

¶ See, as a striking illustration of this truth, the remarks of Mr. Laing, M.P., in his work on the 'Pre-historic Remains of Caithness' (Williams & Norgate), especially at p. 56, where he compares the Caithness aborigines with the inhabitants of Terra del Fuego, as described by Darwin.

to the rank which he continues to hold, of one of the greatest naturalists the world has ever produced.

When Darwin's hypothesis concerning the origin of species is compared with that of Lamarck, that is to say, when we consider the evidence brought forward by our illustrious contemporary in support of his theory, as compared with the reasons adduced by the eminent French naturalist, who may be regarded as the original exponent of that theory,* we cannot help being astonished, first at the large amount of experience and information which had been accumulated by all classes of naturalists between the periods at which the two observers wrote; and, secondly, with the immense amount of original thought and observation that Darwin has brought to bear upon the question. This is most strikingly exhibited in the Introduction to the last edition of his work, where the author unintentionally groups around himself as writers in favour of his views, Lamarck, Geoffroy St. Hilaire, the Hon. and Rev. W. Herbert, Dean of Manchester, Prof. Grant, the Author of 'The Vestiges of Creation,' Prof. Owen (!), (he had not read the Introduction to Owen's 'Comparative Anatomy of the Vertebrata,' just published, or we think he might, perhaps, have omitted this celebrated palæontologist), Isidore St. Hilaire, Schaafhausen, the Rev. Baden Powell, Mr. Wallace, Prof. Huxley, Dr. Hooker, and others. We say "unintentionally" because he does not call them believers in *his* theory, but in that of the modification of species, of which he is the latest and most able exponent; and he might with propriety have added half-a-score of highly-respected and well-known naturalists (in the widest sense of the term), who, not unwisely, delayed the expression of their views until they should have had an opportunity of forming a clear and well-founded judgment upon his theory, and some of whom may be called his disciples, with a certain amount of reservation

He bases his opinion that living species are the modified descendants of other pre-existing species on various observed facts in nature. First, because it is possible to produce, and he has himself succeeded in producing, such a degree of variability in species under domestication as almost to amount to the creation of a new species, and he thinks that what he and others have been able to effect imperfectly, in a brief period of time, could easily be completely brought about by "Nature" in a practically indefinite period. Man, he says, does not actually himself produce variability, but this is accomplished by the conditions in which he places the creatures acted upon; and if they can produce it in one case (under domestication), they can in another (in nature). Let us inquire into the accuracy of these views as we proceed, and observe that whilst we are prepared to give him the full benefit of his *effects*, we

* Buffon had some vague ideas concerning the transmutation of species.

must demur to his construction of causes. It is true that man does not produce variability himself, in one sense, but he does so in another, and in the highest sense. Speaking of selection by man, the author says:—

"If selection consisted merely in separating some distinct variety and breeding from it, the principle would be so obvious as hardly to be worth notice; but its importance consists in the great effect produced by the accumulation in any direction, during successive generations, of differences absolutely inappreciable by an uneducated eye; differences which I, for one, have vainly attempted to appreciate. Not one man in a thousand has accuracy of eye and judgment sufficient to become an eminent breeder. If gifted with these qualities, and he studies his subject for years, and devotes his lifetime to it with indomitable perseverance, he will succeed, and may make great improvements; if he wants any of these qualities he will assuredly fail. Few would readily believe in the natural capacity and years of practice requisite to become even a skilful pigeon-fancier."*

If it necessitates such an amount of judgment, such indomitable perseverance, and so practised an eye to detect the slight differences needed for artificial selection, that even our illustrious experimenter and observer admits that he is unable to appreciate and avail himself of them, is it not at least a rational, or let us rather say a scientific inference, looking at the phenomena of Nature, that an Intelligence beyond our conception, but still acting in Nature as Man does in artificial breeding (for if it be otherwise, Darwin's theory falls to the ground), that such an omniscient Intelligence, we say, is ever and ever watching, directing, and employing each minutest change, producing cause and effect, co-adapting and co-arranging all things to perfection? But we shall have occasion to show hereafter that the author does not believe that the changes referred to are brought about "by means superior to, though analogous with, human reason," and if he has intended in some other manner to acknowledge his belief in an *ever-active* Providence, his volume has failed to convey such an impression.

And believing that "Natural Selection" is the agency in modifying species, the author considers that it acts by seizing upon, and transmitting it to its progeny, any slight differences which distinguish the individual from its parent, and which may be conducive to the welfare of that individual. In other words, if a change is taking place in external nature ("the conditions of existence"), and if a particular individual happen to possess an attribute, be it structural or instinctive, which better adapts it to that change, then "Natural Selection" marks that individual for its own purposes, just as man selects his ram or his ewe, his dog, his horse, or his pigeon, and the law which the author calls "the hereditary transmission of peculiarities" perpetuates the

* 'Origin of Species,' pp. 32-3.

distinctive and beneficial feature in the offspring, and a new variety is formed. The gradual accumulation of such differences, transmitted from generation to generation, at length forms, according to Darwin's view, a new species, then a new genus, a new "family," &c. The varieties, species, genera, or families not possessing these advantageous modifications, die out in "the struggle for existence," from their unfitness to cope with new natural obstacles, and to live under the changed conditions by which they are surrounded.

Now it will at once strike the reflecting reader, that before "Natural Selection" can lay hold of any divergences of character (physical or instinctive), those divergences must have made their appearance, and the inquiries naturally suggest themselves: How do these differences originate? And how does it happen that the new features have been of such a nature as to render their fortunate possessor better adapted for the conditions of existence? (Of course, we do not lose sight of the fact that changes injurious to the animal or plant may also present themselves, and these, the author tells us, are neglected or unheeded by "Natural Selection," which only seizes upon *advantageous* peculiarities, "favouring the good and rejecting the bad."*)

That there may be no misunderstanding, we will hear what the author himself says on the subject: 1. "Natural Selection" cannot *produce* any variation in structure or instinct;† and it can only act for the good of each being,‡ by the preservation and accumulation of inherited modifications, each profitable to the preserved being.§ It acts only by "very short and slow steps," and cannot produce any great or sudden modification.‖

Here we must stop to inquire: If no visible external influence can give rise to fresh variations in structure, what other natural or secondary cause *can* do so? The answer is, "sexual causes," or sexual phenomena; for such terms as "tendency to variation" or "laws of growth" do not indicate causes, but imply ignorance of them.

What, then, does the author tell us about sexual causes? With him it is "sexual selection," and he thinks, 2. That "a change in the conditions of life," by specially acting upon the reproductive system, *causes* or increases variability.¶ But is this not reasoning in a circle, or, worse still, is it not a direct contradiction of his own proposition, that "natural selection" cannot *produce* variability? We are not splitting hairs, nor cavilling about words, for he tells us distinctly in one place that natural selection "can act on every internal organ, on every shade of constitutional difference, on the whole machinery of life."** And again, in another place: "It

* 'Origin of Species,' p. 502, par. 2; and in many other parts of the work.
† Ibid., p. 107, par. 2, "Unless favourable." &c; p. 84, par. 2; p. 100, par. 2.
‡ Ibid., p. 86, par. 2. § Ibid., p. 151, par. 1: and p. 492, par. 2.
‖ Ibid., p. 504. par. 2. ¶ Ibid., p. 86, par. 2. ** Ibid., p. 87, par. 2.

(Natural Selection) can modify the *egg*, *seed*, or young, as easily as the adult.* The more one reads and reflects, the more puzzled he becomes as to the powers attributed by the author to "Natural Selection." At one time it is "Nature," and is compared to Man,† that is to say, to Man's *mind*, for it acts intelligently. Again, the "Conditions of life" are not the same as Natural Selection, for "Indirectly, these" (the conditions of life) "seem to play an important part in affecting the reproductive system, and thus *inducing* variability; and Natural Selection will *then* accumulate all profitable variations, however slight, until they become plainly developed and appreciable to us.‡ Here it is "the Conditions of life,' something distinct from "Natural Selection," that *begin* the work of modification; and yet, as we have been told, "Nature," or "Natural Selection," can itself act on every internal organ, on every shade of constitutional difference, on the seed, and on the egg; in fact, she, or it, *can* commence the work of variation as well as complete it. A very easy mode of solving the difficulty would be the omission of "Nature" (which, if it means anything, means the visible world), and the substitution of "an intelligent Deity," availing himself of His knowledge and power, and acting through His material world, to bring about all those changes to which the author refers.

But, unfortunately, we are precluded from substituting such an "hypothesis" on the authority of the author, for, as we have already stated, he tells us distinctly that he does not believe the more complex organs and instincts to have been perfected "by means superior to, though analogous with, human reason, but by the accumulation of innumerable slight variations, each good for the individual possessor." §

Is not this the same as though he were to tell us that he does not believe the perfected steam engine to be the product of human intelligence, but the gradual accumulation of slight improvements in and additions to its various parts?

But let us set aside for the present the cause, and by that we mean the active, intelligent agency, which is always modifying living beings, whether that agency be the Almighty in nature, or man by art; and let us confine ourselves to the simple propositions that all beings are and have been the modified descendants of pre-existing ones, and that if we were fully acquainted with the biological history of the globe, we could trace all living races of plants and animals back through their ancestry to the "few forms or one" into which Darwin believes "the Creator originally breathed life with its several powers;"‖ and also that the conditions of life in

* 'Origin of Species,' p. 114, par. 2.
† Ibid., p. 87.
‡ Ibid., p. 151, par. 1.
§ Ibid., p. 492, par. 2.
‖ Ibid., p. 525.

which the various living tribes have been placed, were such as favoured, or conduced to the calling forth, popularly speaking, of new powers and instincts. Thus limiting our inquiry, we find in his great book a mass of evidence almost sufficient to establish the hypothesis of Lamarck, and quite enough to justify naturalists in assuming that new species have so arisen, until some still more amplified rule is presented to them. Neither can we deny their right to adopt Darwin's theory as their guide in classification, as the nearest approach that has yet been made to a scientific method of explaining the leading biological phenomena of nature.

One great objection that has been raised against his mode of accounting for the origin of species is, that he has not himself been successful in breeding a new variety, which, when crossed with others from the same parent stock, produced a sterile offspring; in short, that he himself has been unable to make a new species. This fact has, we think, been unfairly weighed and treated both by the eminent investigator and his opponents. The former seeks to prove that infertility is not the infallible rule with crossed species in nature; and he takes great pains to make light, as it were, of the phenomenon as an objection to his theory. If he had succeeded in this better than he has done, he would simply have shown his unprejudiced readers that the exceptions prove the rule; but it would, as it appears to us, have lent additional strength to his cause if he had fully admitted this well-established law of nature. For it is quite natural and completely in agreement with the view that the Almighty slowly changes the instincts and structures of living beings in accordance with the changing surface of the globe, that those instincts and structures should, by becoming more and more divergent, cease to render the possessors attractive to and conformable with each other. This plain mode of regarding the question causes the presence of a new species to assume quite a fresh significance; and this aspect of the case appears to us well worthy of consideration. The controlling influences of external nature, although analogous to hybridism,* may not be sufficiently rapid in their operation to serve as a check upon the production of new beings, and therefore it would appear that Providence has applied hybridity as a special check,† a kind of ratchet, as it were, upon the revolving wheel of life; and thus appears to be prevented that reversion to the original stock which might otherwise take place through uncontrolled inter-crossing, and also a too rapid production of individuals on the surface of the globe. The appearance of a new species is, according to this view, to be considered as the result of an impeditive or conservative influence, rather than one of the progressive phenomena in nature.

* See 'Origin of Species,' p. 299, last paragraph.
† In this Darwin does not believe. See ibid., p. 299, par. 2.

As to the opponents of the theory, their readiness to employ the author's inability to create a new species, has rarely been the result of honest scepticism, for they have rather sought to show what he has *not* been able to effect, than ready to estimate the value of what he *has* accomplished. Upon his line of argument, however, there can be little doubt that hybridism becomes a much graver objection to the theory of transmutation, than if we consider it as a special check applied by Providence (probably in the process of fertilization) and in the manner and for the purposes specified; and this is another weak point in an otherwise well-founded theory.

The most striking data in favour of descent with modification, and those which are likely to be multiplied from year to year, relate to the geographical distribution of plants and animals, and to their paleontological history. We have already touched upon some of the facts observed by Darwin before he was a believer in his own doctrine, whilst still on his travels; and if our readers wish to study the subject fully, we would refer them more especially to his account of the Galapagos Islands,* and of the geographical distribution of American animals,† and would recommend a comparison of these his earlier researches with the chapter in his 'Origin of Species' upon geographical distribution. But here, it will be more useful if we bring before our readers an example of the mode in which the theory is silently working its way amongst those naturalists who are directing their attention to this phase of the subject.

In Numbers II. and IV. of this Journal (April and October, 1864), there appeared two papers, one by Dr. Sclater, a general zoologist, "On the Mammals of Madagascar;" another by Mr. Trimen, of Cape Town, a lepidopterist, on the Butterflies of the same island. Of the experience and abilities of these, our contributors, it would be superfluous, perhaps unbecoming, on our part, to make any comment. From the two papers, it would appear, that while the mammals of Madagascar are almost entirely peculiar to that island, having but slight affinities with those of Africa and the East Indies (chiefly with the latter), the butterflies of the same island are almost the same as those of the nearest mainland, Africa. Dr. Sclater seeks to explain the peculiarities of the Mascarene fauna, 1st, by assuming the truth of the theory of the "Derivative Origin of Species;" and 2nd, by supposing that anterior to the existence of Africa in its present shape, a large continent, which he proposes to call "Lemuria," occupied parts of the Atlantic and Indian Ocean; that this continent "was broken up into islands, of which some became amalgamated with the present continent of Africa, and some, probably, with what is now Asia," and that in Madagascar and the

* 'Journal of Researches,' p. 393. † Ibid., pp. 131 and 326.

Mascarene Islands we have existing relics of this great continent, which he regards as "the original focus" of the Lemuridæ, the characteristic Mascarene group of animals.

But Mr. Trimen could not see the necessity for the creation of this vast continent, so promptly conjured up and baptised by Dr. Sclater, finding, as he did, in Madagascar, "eighty-one species of diurnal Lepidoptera, of which forty-seven are known to be natives of Africa, while the great majority of the remaining species exhibit unmistakeable affinity to African forms." Had such a continent existed as that believed in by Dr. Sclater, "how is it," he asked, "that the same divergence of species has not taken place between Mascarene and African insects (which are numerous in individuals and rapid in succession of generations), as we find between Mascarene and African mammals?" In concluding his article, Mr. Trimen just hints at the possibility of butterflies flying or being wafted across a barrier impassable for mammals!

Now, as these curious phenomena present a direct bearing upon our inquiry, we have been seeking as much information as possible upon the past history of the localities referred to; that is to say, upon the paleontology of the east coast of Africa and the west coast of Madagascar, hoping that that would throw some light on the subject; but to our regret, we find that nothing is known of either. In the course of our inquiries, however, we received a note from one of those whom Darwin may justly reckon amongst the "young and rising men" of science, to whom he looks for the complete establishment of his theory, from Mr. H. M. Jenkins, the Assistant Secretary of the Geological Society, and this correspondent demolished Dr. Sclater's continent of "Lemuria" almost as unceremoniously as it had been brought into existence, and substituted the "infinitely more likely hypothesis," based upon known laws of paleontology, that "a connection had doubtless existed between Africa and Madagascar at some more or less remote tertiary period," but that "the tide of emigration or chain of affinity (between the Mascarene mammals and those of other continents) passed through Europe, *southwards* into Asia, Africa and America, in Eocene or Miocene times."* We are not aware whether Dr. Sclater considers himself a disciple of Darwin, as does our correspondent last referred to; nor can we observe in the facts before us that either reasons strictly upon the Darwinian hypothesis, for according to the views of the great naturalist, there should be a nearer affinity between the mammals of Madagascar and those of Africa, which is separated from the island by a narrow ocean channel, than between the former and the mammals of India, which is much further removed, whilst the contrary appears to be the case; but one thing

* Of course we are authorized by our correspondent to publish his views.

is quite clear, namely, that however much these naturalists may differ from one another, two out of three agree with Darwin as to the "derivative origin of species;" and as it appears to us, the third (Mr. Trimen) unconsciously adds another link to the strong chain of evidence in favour of his theory presented by the geographical distribution of animals.*

But the plain facts of paleontology, as well as its empirical laws, tell forcibly in favour of a slow and gradual modification of species. Before Darwin's views on the subject were published, Vogt, a well-known German systematizer, had already interlinked into his graphic account of recent forms, the fossil species which serve in some degree to bridge over the structural gaps that occur amongst the former; and from every portion of the world, as the soundings of its crust are taken, we receive fresh accounts of missing links in the chain of beings. One grave difficulty in the way of the acceptance of the new theory, which would have sufficed to daunt many an ardent investigator, has of late been partially removed. Darwin, of course, does not believe in the miraculous creation of new species, and expresses his surprise at the credulity of those authors who imagine "that at innumerable periods in the earth's history, certain elemental atoms have been commanded suddenly to flash into living tissues;"† but when he asks himself, "How far do I extend the doctrine of the modification of species?"‡ he is, or rather was, necessarily unable to give anything like a satisfactory reply; for when he sought to trace the origin of life in the rocks, he was arrested apparently at the extremes of the palæozoic strata by fossil forms, lowly, indeed, as compared with the vertebrates, but still far higher than many that now swim our seas and streams, and it was just as difficult to explain how these were created without ancestors of a still more primitive type, as it would be to account for the Origin of Man under similar conditions. Scarcely, however, had the first sounds of the violent controversy which followed the publication of his work died away, when the intelligence reached us from Canada, that in the primitive rocks there, which had been deemed void of life, the remains of a type resembling one of the lowliest living organisms had been discovered, and naturalists, in their accustomed haste to generalize, have termed it Eozoon—the first or earliest living being. Darwin frequently refers to the imperfection of the geological record, and although it is hardly probable that we shall ever have a perfect record whilst a large portion of our globe is covered with water, still we recognize in the discovery of the humble type alluded to, an augury that a

* *Vide* 'Origin of Species,' p. 416, beginning "Sir Charles Lyell;" and p. 427, par. 2, as to the whole question between Dr. Sclater, Mr. Trimen, and Mr. Jenkins.

† Ibid., p. 517, l. 19, 20.

‡ Ibid., p. 518, l. 4.

sufficiently extensive collection of data will be presented to us to enable us—or we should rather say, to enable posterity—to form an accurate judgment as to the order and succession of living beings in ancient times and their relations to living species.

So far, these data are all in favour of the theory of the origin of species through modified descent; and a few would-be orthodox naturalists, who seek to explain the facts of paleontology otherwise, prefer to trump up absurd and, as it appears to us, irreverent theories of their own, rather than to accept the simple truth as it has pleased the wise Creator to engrave it upon his enduring tablets of stone.

The investigation of the origin of life on the globe hardly comes within the limits of this inquiry, and Darwin scarcely mentions it. At present it is still very obscure, and many generations may pass away before we are enlightened with regard to the mode in which living beings originate—possibly that may be an inscrutable problem for ever—but a far more relevant and striking feature in our inquiry is the origin of Man himself. There seems to have been an impression amongst naturalists, including many of the most able, that if the doctrine of transmutation be correct, man must necessarily be a direct descendant from some ape; but why this should be, it is difficult to understand. If any unprejudiced inquirer will take before him the table that illustrates Darwin's book,* and with that for his guide, will carefully consider all the leading facts which have of late been so largely debated in connection with Man and the Simiæ, we venture to think that he will not be disposed to admit the necessity of Man's ape-origin, be he ever so firm a believer in Darwin's theory; but, on the contrary, that he will regard it as more probable, that whilst the highest ape stands at the head of one succession of types, about to become extinct, Man is at present placed at the highest pinnacle of another; though it is highly probable, looking at his present condition and his faculty for improvement, that his past lineage is brief when compared with its future extension.

There are many obscure points connected with the 'Origin of Species,' on which it may be said that we have expressed ourselves with uncertainty, but there is one, respecting which we desire to be very explicit. We have no sympathy with the aversion manifested by some men towards the development theory on the ground of feeling. It was doubtless as offensive to the dignity of our forefathers, when they were told that they were not the denizens of a world around which the universe revolved, as it is to some persons in the present day to hear that we cannot "go with the angels" here, as long as our animal nature adheres to us. But will anyone maintain that the earth has lost any of its dignity, or is less noble,

* 'Origin of Species,' p. 123.

because it revolves around a luminary from which it has derived its being (physically speaking), but which is probably of a lower cosmical nature than it is; and should it in like manner be shown (as will probably be the case) that our animal frame is derived by the usual generative succession "from some lower stock" of animal, will anyone hereafter venture to say that man is less noble on that account?

But certain well-ascertained facts appear to militate strongly against the assumption that man is descended in a direct line from the apes. 1. Although very degraded types of mankind exist amongst us to-day, and traces of similar beings have been discovered in the later geological formations, it is admitted that no form has yet been revealed, which serves as the approach to an intermediate link. The most impetuous followers of Darwin are the most positive on this point. 2. Although we find at the present day savages almost as untutored and undomesticated as any *animal* "Man," of which we can form a conception—indeed, in some cases almost below the highest domesticated animal in their mental character—and although these beings must have existed through untold ages, often exposed to every state of the weather in absolute nakedness, there has been no reliable case of a tribe reverting to the hairy type, nor any trace of such a variety of the human race having existed as aborigines in former times. And 3. Whilst the intelligence of the apes cannot be said to have advanced in proportion to the complexity of their organization, but to have reached its climax before we approach those forms nearest to Man; the intelligence of Man appears to be of a different nature to that of the apes, which are even less capable of sympathizing with man than some of the domestic quadrupeds; and this intelligence, *sui generis*, appears just to have entered upon the dawn of its development, and to present an unlimited future.

But whilst the problems of the origin of living beings and of Man present no serious obstacles to a belief in the simple doctrine of the transmutation of species, they do offer fatal objections to Darwin's version of that theory. If his law of natural selection is valid in one case of animal progress, it must hold good in all, and he has no more right to pass over the consideration of "the first steps in the advancement, or in the differentiation or specialization of parts," in "looking at the dawn of life"* (in the lowest types of animals) as an inscrutable problem, than he would have to select any other phenomenon difficult of reconciliation with his law. And then what has he to say concerning the origin of the sexes themselves? It is true, he tells us that "he is strongly inclined to suspect that the most frequent cause of variability may be attributed to the male and female reproductive elements having been *affected* prior to the act of conception;"† but we would appeal to readers

* 'Origin of Species,' p. 137. † Ibid., p. 8.

of every shade of opinion, whether this is not what the illustrious naturalist himself so often calls, when he refers to the theories of his opponents, a restatement of facts. And where was the necessity for the very existence of the sexual elements at all? What "law" of nature created these? We know that many of the lowest types of animals can and do multiply rapidly and effectively by fission (subdivision of their bodies) and gemmation (budding); and we know, too, not the least so from the wonderful array of facts collected by this most untiring observer, that the pivot upon which the whole question of animal progress turns, is just this one of sexual peculiarities! From the very commencement of life up to the present hour, there are evidences of an *immediate* designing power—or, to use a term which is looked upon with disfavour by many Darwinians, an *ordaining* Power; an occult influence in the production and modification of the sexual elements, and consequently of the beings springing from them, totally distinct from the "conditions of existence," "natural selection," or whatever else the force may be called, which influences the embryo and the born creature. How often is it that the deceased *father* is resembled by his posthumous offspring? Had it been the mother, this might be explained by the conditions of gestation; but to what is it to be attributed in the case of the father? Is there anything in Darwin's law—is there not something beyond "atavism," or "the hereditary transmission" of peculiarities (phrases themselves implying ignorance, not knowledge, of natural laws and operations), which causes this constantly-recurring miracle connected with the conception of living creatures?

But the facts of embryology afford very striking evidence in favour of the origin of species by modified descent, and undoubtedly the surrounding conditions of existence have great influence upon the growth of the embryo. The resemblances between the fœtal stages of the individuals of different species, too, lend additional probability to the same doctrine; but whoever has the smallest acquaintance with Comparative Embryology must know that whatever value its facts may present in enabling us to judge the question under consideration, they apply equally to Man and to the lower animals.

It is not surprising that when Darwin comes to treat of instincts, he should find in their study but little in favour of his theory of Natural Selection. Still he believes that the latter has the power "of accumulating slight modifications of instinct to any extent in any direction;"* and judging by analogy, that is, when we compare this with similar language relating to the modification of the structure of animals, we should be justified in inferring that he believes natural selection to be capable of framing the minds of animals. On

* Origin of Species,' p. 229, par. 3; p. 265, par. 2.

the other hand, we can hardly believe that he assumes so much for his favourite theory, for elsewhere he says, "I do not pretend that the facts given in this chapter strengthen in any great degree my theory, but none of the cases of difficulty to the best of my judgment annihilate it." * That visible nature, in some cases, limits and retards, in others stimulates the physical as well as the bodily activity of living beings, no one will deny, and that such an influence is as applicable to Man as to the lower animals, is just as obvious; but that nature has been, or is, a power, in the well-understood acceptation of the term, acting upon the mind of animals, or of man, or anything but an unconscious agent, very few will admit, and we can hardly believe that the illustrious naturalist himself holds such a creed.

Sometimes, indeed, the "conditions of existence" are all-powerful in evoking the nobler qualities of animals and men. For Man these "conditions" may be a forest glade, a range of towering peaks, a well-stocked library, a few tuneful sentences; any of these may fan the latent spark of genius, which has lain smouldering for years, and cause the flame to burst forth suddenly. But there are cases where, notwithstanding that the "conditions of existence" may have a repressive tendency, the "instincts"—or in Man the soul—will assert its supremacy, and will mock all Darwin's laws and theories. See, for example, the ungainly peasant, who, under the law of the "hereditary transmission of peculiarities," should have pared his turnips, chewed his bacon, and guided his plough, as did his ancestors before him—how he, encircled by the same "conditions of existence" as surrounded them, spurns their grovelling pursuits, dives down into the depths of physical truth and brings up some pearl of inestimable price, which his "highly educated" fellow-men have in vain been seeking on the surface; or soars upwards to the sky, and descends again with other truths, less pleasing to the sense, perhaps, but serving as another link in the bright golden chain uniting Earth and Heaven.

In this review of some of Darwin's labours, we have been led into many digressions, for which the eminent author is to some extent responsible, for a more suggestive series of works than his has rarely been published; and this we conceive to be one of their most valuable elements. The objection to his theory of "natural selection"—and it is a grave one for the reason already assigned—is, that he refers all the perfect operations of Nature to an imperfect law. Then we may be asked, Why should such a law be regarded? Simply, because it is the best extant. Why, we would ask, is society ruled by imperfect laws? Why is honesty in trade, to a large extent, maintained by clumsy and defective mercantile codes?

* 'Origin of Species,' p. 265, par. 2.

Because it pleases God to give scope for the exercise of the human intellect by reserving a portion of the truth for man to search out, and thus stimulating each successive generation to reform itself.

As far as we are able to judge, after many years' careful and unprejudiced observation, Darwin is right as to effect, and as to cause, he is partially so. In other words, the Ruler of the universe does use the means so beautifully described by him to bring about certain phenomena in nature, but He appears to employ other and still unexplained means as well. Until, however, some naturalist, possessed of larger powers of observation and comparison, and of a courage equal to that of Darwin, shall arise to complete the theory of "natural selection," or, what will more probably be the case, shall substitute a more perfect theory just as this one is more complete than that of Lamarck; until then, we say, "Darwin's law" will continue to guide naturalists of every order in their biological inferences and zoological classifications.

But we cannot help expressing our surprise that so able and observant an inquirer as Darwin can fail to see in the wonderful array of facts collected in his great work, "one long argument" in favour of a constant, ever-watchful, ever-designing, and ever-active Providence. He can perceive the immediate intervention of that Providence in the "original inbreathing of life" "into a few lowly forms, or one," and yet (limiting ourselves strictly to the boundaries defined by him) in the instinct of the bee, which deftly builds its nest, or unconsciously fertilizes the insensient orchid; * in the remarkable powers of climbing plants, which possess the faculty of moving in conformity with the requirements of plant-life, † and equally in the affectionate intelligence of the domestic animals, he can see only the action of "secondary causes," and fails to perceive in all these and a thousand other phenomena of nature and of mind, the *continuous* application of an Almighty Power acting with design. Have too close reasoning and observation drawn a veil across the scene so long admired and watched by our great naturalist, or what has caused this curious obscuration?

This is the great defect pervading Darwin's work; but it is not the weakness of an imbecile, nor yet the foible of an obstinate dogmatist; it is, we hope, the unconscious and, let us trust it soon will be the conscious demerit of a great work, undertaken and partly accomplished by one of the noblest, most exalted, and most brilliant intellects of our age.

* 'On the Various Contrivances by which Orchids are Fertilized by Insects,' (Murray, 1862), p. 2.

† 'On the Movements and Habits of Climbing Plants' (Taylor & Francis, 1865), p. 118.

II. CONSIDERATIONS ON THE LOSS OF THE 'LONDON.'

By William Fairbairn, C.E., F.R.S., &c.

The introduction of iron as a material in constructive art has been attended with great advantages. For the purposes of ship-building it has given greatly increased strength, and afforded facilities for obtaining new forms, which, aided by the power of steam, have ensured a rate of speed in vessels never before attained in naval history. It has, moreover, furnished the naval architect with a material of immense value as regards construction, and its careful distribution in the shape of ribs, frames, and the sheathing of vessels cannot be too highly appreciated. As compared with the best English oak, it exhibits four times its powers of resistance, and it has in addition the double advantage of being almost perfectly homogeneous and free from the defects of open joints, which in the case of the planking of wooden vessels require to be caulked. With all these advantages, iron constructions are surrounded with many dangers when entrusted to the care and superintendence of incompetent persons; in such hands there invariably exists a want of proportion in the formation of iron vessels, which exhibit defective powers of resistance, and such other abnormal conditions as might prove destructive to the efficiency and ultimate security of the structure. It is therefore necessary that the naval architect or builder should be conversant with the properties of the material employed, whether considered separately or in combination, and moreover, he should be satisfied that the vessel, when finished, is capable of permanently resisting the forces of tension and compression, and all the varied strains to which she is subjected when afloat.

In laying down the lines of a ship, all these conditions should be carefully and deliberately considered. It is also of importance to take into account the forms or lines of least resistance, such as a fine entrance at the bows, and an equally clear run at the stern, if high speed is the object to be attained. In such cases, these forms are highly advantageous for vessels navigating rivers and smooth water, but in those intended for long sea voyages, and having to contend with the waves of the Atlantic or the rolling seas of the Cape, it is questionable whether or not some slight sacrifices should be made to speed, and some modification effected in the form of the bows and stern, in order to meet all the requirements of a safe and convenient vessel intended for the double purpose of carrying passengers and cargo.

I have been led to these particular considerations, not so much from the lamentable accident which overtook the 'London,' as from the conviction, that the safety and success of a vessel does not depend so much on its speed as upon its sea-going properties and sound construction. If, for example, we take one of the present iron clippers—which make such quick voyages—with her sharp bows and fine proportions, I am of opinion that she is neither the safest nor the best description of vessel to contend with a heavy sea in foul weather. In the first place, she is a *diver*, which cuts into the sea and rises with difficulty from a *bath*, which covers her decks with water as she pitches from sea to sea. But these are not the only objections to vessels of this form, as repeated immersions of this kind are exceedingly uncomfortable to those on board, and cause the ship to lift some tons of water before her buoyancy is restored to meet the next and every other succeeding wave into which she plunges in a rolling sea. It is not my intention from these observations to depreciate the value of speed either in the Royal or Mercantile navy. On the contrary, I think it is the duty of every ship-builder to approximate as closely as possible to the lines of least resistance, which, in my opinion, ought to be carried to its utmost limits in smooth water, but in smooth water only.

In the construction of vessels of war, it was found expedient to rectify this want of displacement at the bows by projecting the submerged portion of the hull forward in the shape of a ram, not so much, however, for the purpose of attack, as to give buoyancy to the ship, and to enable her to rise more lively upon the sea. These defects of construction were observed in the iron-plated frigates 'Warrior' and 'Black Prince,' the former vessel pitched and rolled heavily in the Bay of Biscay from similar causes, which from the first have been observable in all our high-speed ships. Viewing the subject in this light, it may not be out of place to suggest that all passenger and emigrant ships should be modified in their construction, so as to give increased displacement at the bows and stern, but more particularly at the bows, where they require buoyancy, having to encounter the force of a large body of water rushing over them and scouring the decks from stem to stern. Many of us remember the bluff round bows of vessels of the last century, and how they rolled and pitched in a gale of wind. They were, however, short and compact, and although deficient in speed, they were nevertheless dry and excellent vessels at sea.

For several years I have endeavoured to impress upon the minds of naval architects and others, the necessity of increased strength on the upper decks of sea-going vessels, in order to balance the forces of tension and compression, and the double bottoms on the cellular principle of construction. The ultimate strength of a vessel is the resistance of its weakest part, and this being the case, it is evident that it is of little or no value to have a strong double-bottom if the deck is liable to be torn asunder by the alternate strains of a vessel pitching at sea. That these strains, often repeated, lead to fracture does not admit of doubt, and it has been proved by experiment, that under these circumstances time is the only element in the endurance of the structure, and this varies according to the intensity with which the strains are produced. I offer these remarks from the conviction that heretofore the decks have been the weakest parts, and that several iron vessels have broken right in two from the constant working of alternate strains at midships along the line of the decks. I have also, by way of illustration, compared an iron ship to a hollow girder, supported at each end and resting on the middle for the exclusive purpose of showing the alternate changes to which she may be subjected if stranded or placed in the dangerous position of rising and falling on rocks in a heavy sea. Exceptions may be taken to these views, but they nevertheless exemplify what is necessary to be observed in the construction of a strong ship, and I may probably be excused the comparison, when the object in view is to effect security in the construction of our iron vessels.

I have been confirmed in my opinions on the forms and strain of vessels, from such facts as I was able to gather from the narrative of the loss of the ship 'London.' From the accounts and the different statements of the witnesses examined before the Commissioners appointed by the Board of Trade, I was unable to discover any serious defect in the construction of the ship. On the contrary, I have reason to believe that both material and workmanship were perfectly sound, with the exception of the combings of the hatches, which it would appear were imperfectly secured. As respects the design, I have assumed that she inherited the extremely fine lines at the bow and stern already described, and to which I have directed attention, and additional weight is given to this opinion by the manner in which the vessel behaved at sea. Taking all the circumstances into account, as also the statements of the different witnesses, with regard to the rigging and the state of the decks, I arrive at the conclusion that the ship did not founder from any serious defect of construction, excepting only the insecurity of the hatches, but from the hurried manner in which vessels are sent to sea, with their decks crowded with coal, hampers, and a variety of articles always dangerous and always objectionable in long and narrow vessels that are low in the water and liable to ship every succeeding sea. If these matters and the upper rigging had been properly cared for, there would have been no broken jibboom to batter to pieces the combing of the hatchway, and instead of the 'London' being entombed with all on board at the bottom of the Atlantic, she would, by this time, have been well advanced on her voyage to Australia.

III. SEWAGE AND SEWERAGE.

1. *First Report from the Select Committee (Dr. Brady's) on the Sewage of Towns, together with the Minutes of Evidence and Appendix.* Ordered by the House of Commons to be printed, April 10, 1862.
2. *Second Report from the same Committee.* Ordered by the House of Commons to be printed, July 29, 1862.
3. *Report from the Select Committee (Lord Robert Montagu's) on Sewage (Metropolis), together with the Proceedings of the Committee, Minutes of Evidence, Appendix, and Index.* Ordered by the House of Commons to be printed, July 14, 1864.
4. *Third Report and Appendices of the Commission appointed to inquire into the best Mode of Distributing the Sewage of Towns and applying it to beneficial and profitable Uses.* Presented to both Houses of Parliament by command of Her Majesty. 1865.
5. *The Present State of the Town Sewage Question.* By Gilbert W. Child, M.D., of Exeter College, and Physician to the Radcliffe Infirmary, Oxford. Oxford and London: John Henry and James Parker. 1865.
6. *General Report of the Commission appointed for Improving the Sanitary Condition of Barracks and Hospitals.* Presented to both Houses of Parliament by command of Her Majesty. 1861.
7. *A Manual of Practical Hygiene, prepared especially for Use in the Medical Service of the Army.* By Edmund A. Parkes, M.D., F.R.S. London: John Churchill & Sons, New Burlington Street. 1864.
8. *The Sanitary Management and Utilization of Sewage.* By William Menzies, Deputy Surveyor of Windsor Forest and Parks. London: Longman & Co. 1865.
9. *National Health and Wealth.* By the Rev. H. Moule. 1861. (Pamphlet.)
10. *Memoir on the Cholera at Oxford in the Year* 1854, *with Considerations suggested by the Epidemic.* By Henry Wentworth Acland, M.D., F.R.S., &c. London: John Churchill, New Burlington Street; and J. H. & J. Parker, 377, Strand. Oxford: J. H. & J. Parker. 1856.
11. *Seventh Report of the Medical Officer of the Privy Council, with Appendix.* 1864.

The problems of Sanitarian Science seem sufficiently complex; but the most pressing and primary of them will run in the simple formula: How are we to dispose of our Sewage without either spoiling our rivers, or robbing our fields, or poisoning ourselves?

This particular question may seem uninteresting or even repulsive, but the events of the last few years, and more especially of the very last, have given it a claim on the immediate and close attention of every man who has at heart his own well-being and that of his fellows. It seems also at present far removed from a speedy and definite settlement; but men of science and men of practice rarely work together without compassing their common object; and the conspiracy of modern chemists and engineers with modern agriculturists and sanitarians will assuredly form no exception to the rule.

In this article we purpose, first, to delineate in the merest outline and from the practical as well as from the scientific point of view, the question, as it should be presented to a person, who, living in one of our many needlessly unhealthy towns, has his attention necessarily focussed by what he daily feels and sees and reads upon the subjects more or less systematically treated in the long list of works hereto prefixed And in the second place, we shall point out the special merits and particular claims of each of those works, hoping thereby to place our readers fairly on a level with the present somewhat extensive literature of this department of hygienics.

We take it of course for granted that all who read these lines are convinced of the immediate bearing which the purification of our houses, streets, and streams has upon both the moral and the economical interests of the nation. Market Drayton, indeed, a town belonging exactly to neither of the two counties of Shropshire and Staffordshire, but an equal discredit to both, did last autumn get up a riot in the interests of filth, and rejected the Local Self-government Act, emulating therein, and not unsuccessfully, the conduct of those men of the "most brute and beastly shire" of Henry VIII.'s realm, who sang of old in defiance of a similar movement for their own improvement,—

> "Let us be men,
> And we'll enjoy our Holland fen."

There is, however, no reason to think that many other towns can be found to follow the example; Market Drayton is, so far as we know, a unique instance of such a condition of things in the nineteenth century; and its exhibition of folly and brutishness is probably to be referred to some temporary excellence in the organization of the class which has a direct interest of its own in keeping the low lodging and public-houses, as well as other centres of moral and physical debasement, undisturbed and uninspected. Pure air, indeed, and pure water reduce greatly the need and the desire for stimulants, and the temptation thence accruing to the poor man to betake himself to the gin-palace, so that the gentry we allude to were, in a scientific point of view, wiser in their generation than probably they were aware of. The words, "Thou shalt eat but not be satisfied," precede the words from the Prophet Micah, quoted by Dr. Hunter in his now famous Report,* "And thy casting down shall be in the midst of thee." But as Mr. Simon, to whose good office we owe the Report just alluded to, promises another shortly, which shall show us what such towns as Worksop and Salisbury have really gained by cleansing and keeping themselves clean, we will say no more now and here of the value, urgency, and importance of Sanitarian Reform, but proceed to the details of Sewers and Sewerage.

We may do well to begin by passing in review the different methods which have been proposed and adopted for dealing with sewage whilst within the precincts of our towns, and indeed, of our very houses. All modern and most ancient plans for dealing with sewage refuse aim or aimed more or less directly at its destruction or removal. The Jews used the agency of fire† in the valley of Hinnom, for the purification of their city; and while in the Wilderness they used earth‡ outside their camp as their disinfecting agent. The Chinese and the Japanese have a system for removal of sewage in substance, either without the admixture of other matter, or as compost, but without mixing any special deodorant with it. Agrippa did for the Romans, in the time of Augustus, what Mr. Bazalgette has done for the Londoners in the time of Queen Victoria, and the rush and volume of his main drains has been commemorated by Pliny, and earned the title of "*torrens cloaca*" from Juvenal.

Side by side with these and other systems for the removal of excreta there has existed from time to time a system for its non-removal,—and to it we will now devote a few lines. It might have been hoped that this system was definitely numbered with the things of the past, but we are informed that even in these days it has its adherents, much as Paganism, which it resembles in the matter of foulness, retained and regained occasionally a few votaries long after the acceptance by the civilized world of a purer form of faith.

Mr. Rawlinson declares that though some of the rivers in Lancashire are indescribably foul—so foul, in fact, that birds can walk over them in places—they are less injurious to health than are the cesspools with which the towns in that county are so richly honeycombed.§ A delicate nostril, we are told, can detect the peculiar odour of these abominations in many a well-furnished house in continental cities, in spite of the fumes, whether of tobacco or other

* 'Seventh Report of the Medical Officer of the Privy Council, 1864.' Appendix, p. 256. Micah vi. 14.

† Bazalgette on the Main Drainage of London. 'Proceedings, Institution Civil Engineers,' vol. xxiv., 1864–5, p. 3.

‡ Deuteronomy xxiii. 12, 13.

§ 'Evidence before Lord Robert Montagu's Committee on Sewage (Metropolis),' p. 147 (3,937), p. 186 (4,219), p. 177 (4,058).

more refined perfumes, the empyreumatic and therefore more or less antiseptic properties of which may account for their all but universal employment in such countries. It is, in most cases, a mere mockery to speak of the "hermetical closure" and sealing up of a cesspool; for its liquid contents penetrate almost inevitably into the neighbouring wells, spreading and multiplying cholera and typhoid fever, whensoever these plagues arise among us, in a manner the most unmistakeable. And the air we breathe is tainted by the cesspool even more surely than the water we drink. Such structures are, in fact, gasogenes of the very foulest kind; and even when they are not placed directly beneath a house, as of old, the draught exercised by the fires in the houses they are connected with, and the specific lightness of the gases themselves, make their access to every room a certainty, in the default of an all but impossible system of trapping and ventilation. The condition of Chichester, as given in a recent Privy Council Office Report, and as contrasted with the condition of Salisbury, is, perhaps, a crucial instance of the effects of the cesspool system of non-removal of sewage. Mr. Menzies, Professor Way, Mr. Henry Austin, Mr. Rawlinson, and the Barrack Improvement Commissioners, all alike denounce the system unsparingly in the different books placed at the head of this article; and a certain Sanitary Commission, called the Metropolitan Commission of Sewers, abolished in the year 1847–1848 no less than thirty thousand of these centres for pollution,* in what is now the healthiest capital in Europe. But though science and practice are both alike so opposed to its being, the cesspool has yet its proper place and right to existence. In the case of houses in the country, with land about them in large quantity—measured, that is, by the pole and perch, and not by the square yard or foot, not built upon, nor to be built upon—a cesspool constructed so as to be as nearly watertight as possible, fitted with ventilating tubes and trapped, may be entirely innocuous, and by the addition of purifying apparatus made highly profitable. Indeed, even in a town, a person who possesses a large garden may, by placing his cesspool at the most distant part of such garden, contrive that it be, if not wholly uninjurious to his neighbours, at all events, nearly so to himself.

Of the various plans for removal of sewage, the simplest is that which merely takes it away without the addition to it of any water or the admixture with it of any disinfectant or deodorant substance. It has or might have its place and application in regions where from extreme drought or extreme cold, water is not available for the same purpose, and where labour is cheap. In a populous town and a civilized country the watertight carts which would be necessary for carrying out such a system would be so numerous as to block up† the streets, and whilst thus rivalling all other modifications

* Bazalgette, *l. c.* p. 6.

† Rawlinson: 'Evidence, Lord Robert Montagu's Committee,' p. 184 (4,177).

of the "dry method" in cumberousness and expense, it exceeds them all considerably in offensiveness. Mr. Menzies, however, shall describe its demerits for us:—"There is no doubt," he says at page 6, "that this affords the least complicated means of utilizing the sewage; but the whole tendency of the people in this kingdom is towards cleanliness, and they will readily sacrifice what is apparently useful if anything so disagreeable as this is forced upon them. This system is carried out thoroughly in China and Japan; but its advocates admit that Europeans endure a martyrdom of smells in these countries, while they forget that a vast amount of human labour in these two countries is the cheapest form of transport, while in Europe it is the dearest; also that in Britain nothing is more studied or better understood than engineering and mechanical arrangements which involve the least outlay of either skilled or unskilled labour. Neither do the towns in China and Japan yield, like those in this country, vast quantities of horse manure, which is much more easily managed, and which by its abundance in the neighbourhood of large towns in England diminishes the agricultural value of sewage. Nor could this system of iron pans be adapted to dwelling-houses."

On the other hand, it is right to say that Sir Joseph Paxton, though, as a horticultural physiologist, he was fully aware that "plants could not take up solid manure in its crude form, the spongioles becoming ulcerated by contact with it, and that therefore an application in a diluted form was the application by which plants were best supplied," did, in his evidence given before Dr. Brady's committee (see Second Report, p. 17, 2,511), hint that mechanical science might one day make a removal in this way very possible, "without our ever knowing anything about it or having the slightest possible smell in the house." "In the diluted form," he proceeds to say, "it is very valuable, but in the solid form it would be commercially much more valuable." The plan is employed in certain barracks in Germany and also at Glasgow.* The Japanese and Chinese are ordinarily taken as illustrations of the success which may attend the adoption of this plan; and we are far from thinking that we may not learn many valuable lessons from nations whose vast experience and urgent necessities must have forced upon them so many lessons of ingenuity and economy. The Rev. Mr. Moule, indeed, of whom we shall have to speak again,† has recommended for adoption in English cottage architecture a plan of utilizing the heat of the fire in hollow house walls, the principle of which has for centuries been acted on by Chinese builders; but in this matter of the utilizing of sewage, we are inclined to think that the difference of our social conditions

* See 'Report Barrack Improvement Commission,' p. 91, and figure in illustration.

† 'Gardeners' Chronicle,' June 18, 1864.

renders their example inapplicable to us. It is their habit* to dilute their manure very largely, even though not so largely as to the extent of the forty gallons of water per head of London extravagance, before they apply it to the land.

The poudrette of the Patent Eureka Company, on the other hand, is sown broadcast over the land in a dry form,† a plan which we think contrasts to disadvantage with these Oriental methods, and which must ultimately impair somewhat the success which, we learn, has been considerable in the town of Hyde. Even the Chinese, as we gather from Mr. White's evidence,‡ put on record in the Blue Book last quoted, "have the idea that manure, whether the production of bipeds or quadrupeds, if applied to land in a dry state, burns the plant." Of the carriage of the material whence this poudrette is manufactured, from the places where it is produced to that where it is operated upon by the Company, nothing need be said beyond what we have already hinted at, as to the encumbrance and annoyance which a crowd of "collecting carts" would create in our streets. Of the process of manufacturing it, we read nothing unfavourable in the evidence given (*l. c.*) by the chairman of the Company.

Of the different plans for the removal of refuse by the agency and with the assistance of one of the three "elements" of the ancients—earth, to wit, water, and fire, the last is, from a purely chemical point of view, the best, as being the most thoroughgoing. It is organic compounds, containing either nitrogen, or sulphur, or phosphorus, or all three of these substances, which form the most deleterious products of sewage; and the state of perfect oxidation into which burning brings them, even if it does not confer any infinitesimal disinfecting power upon their *disjecta membra*, renders them wholly innocuous as miasms. This method of destroying refuse has again and again been recommended and employed in epidemics, with the best results; and it has been recently recommended by the Cattle Plague Commissioners. But in happier and ordinary times it will be, we hope, inapplicable in practice, though so perfect in theory—such worship of Moloch would be intolerable in a country where furnaces have been occasionally, and steamboats not rarely, compelled to consume their own smoke. We leave the subject, therefore, with the remarks that the partisans of the "Cinereal" theory of manures would do well to show their faith by establishing such works for dealing with refuse as the Jews had in the Valley of Hinnom. When they have done this, then, but not till then, will Mr. Lawes be held to have had the worst of the argument, and the German substitution of "nitrogenous" and "non-nitrogenous manures," for "organic" and "inorganic manures," be believed

* Liebig's 'Natural Laws of Husbandry,' p. 393. Dr. Brady, 'Second Report,' p. 71.
† Dr. Brady's Select Committee, 'Second Report,' p. 21 (2,600).
‡ Ibid., p. 6 (2,335).

to give a full and true account of the points really at issue between Rothampstead and Munich.

The "earth-closet" system, as advocated by the Rev. H. Moule, of Dorchester, is scientifically well-nigh as thoroughgoing as the system of purification by fire. It is even less amenable to objection on the score of offensiveness; but we fear that considerations of expense, as well as the mechanical ones of difficult conveyance and transport, will restrict the sphere of its application to certain public institutions, and render its adoption impossible, at least to any great extent, in private dwelling-houses.

The ordinary Englishman has an extraordinary horror of domiciliary visitations, and especially does he abhor them when they are of the kind which this system postulates. The economist knows that suspension in water is a cheaper, as the least economical of men knows it is a less offensive, mode of carriage than any modification or adaptation of the scavenger's cart. And, finally, the agricultural chemist thinks, indeed, that earth is the true medium for the deodorization and the utilization of sewage, but he thinks also that the true way of acting upon this conviction is to bring the sewage to the soil in the irrigated meadow, not the soil to the sewage in the earth-closet. But we should not be doing justice to our convictions, if we did not recommend Mr. Moule's pamphlet most strongly to the attention of our readers, and express our belief that this system, though not so universally applicable in this country as the system of removal by water, may yet—under certain circumstances, and especially under such conditions as attach to public institutions—be found of easy application and permanent usefulness.*

Of the plan which would substitute ashes and ashpits for earth and earth-closets, we must speak in very different terms. The advocates of that system should assuredly be sent to Coventry to learn what its working really is. The mayor of that town we find giving evidence to the following effect before Dr. Brady's Select Committee (see 'Second Report,' p. 85, 4,497). Mr. F. Wiley: "In all new houses, we will not sanction a plan unless they build a water-closet, because we consider the wet ash-pits which are used so injurious to health. As a medical man, I really have seen so much evil from those nasty ash-pits in a yard half-full of sewage, that no poor people ought to be allowed to live near them." 4498. Mr. Caird: "Not if they are nasty?"—"They are all nasty; not a private house can drain them, and the corporation will not allow you to drain an ash-pit into the sewers; these ash-pits generate fevers in the neighbourhood; I believe the nasty ash-pits in towns are the greatest source of fever; they poison your water and they poison

* We cannot speak from personal knowledge, but we understand that Messrs. White & Co., of Bedford Street, Strand, London, have made arrangements for demonstrating the mode of operation of Mr. Moule's invention in all its different forms.

your air." This is to the point. And we may add that, according to a paragraph in the 'Times,' of November 16, 1865, the ash-pits of Manchester take their fitting place, amongst some half-dozen barbarous abominations, as causes of a recent severe outbreak of fever in that unwholesomely managed city.

The water-closet system for the removal of excreta comes lastly for consideration—a system which, though of recent date, and, out of this country at least, of comparatively limited development, is yet in a fair way towards establishing itself ineradicably in the domestic arrangements of the upper classes of civilized nations. Its economical merits rest on the engineering axiom, "Carriage by suspension in water is the cheapest mode of transport;" and its merits on the score of inoffensiveness need no other exposition than a certain country will furnish, in which the water-closet is even now something of a novelty, and known even yet by the name of "*Cabinet Anglais*." Its demerits are—first, in an agriculturist's eyes, the exceeding dilution to which it subjects manurial matters at all times, and most especially at times when the country is already saturated with rainfall; and, secondly, from the sanitarian's stand-point, the great liability to derangement under which it labours at times of severe frost in wealthy, and at all times, in poorer houses. Of the agricultural difficulty, Mr. Menzies offers one solution, and to this subject we shall recur, addressing ourselves in the meanwhile to the Hygienic aspect of the system. And it must be confessed that here, as elsewhere, the old proverb holds good, "*Corruptio optimi pessima*." All-efficient, innocuous, and inoffensive as is the in-doors water-closet if properly fitted up, it may be made as noisome as, and assuredly will be more noxious than, the old-fashioned out-door retreats, if it be not so fitted up. The precautions to be taken relate, first, to the lighting and ventilation of the room itself; secondly, to the ventilation and trapping of its outlet-pipes; and, thirdly, to the communications which these discharge-pipes are allowed to set up with other waste-pipes. These precautions we will give in the words used by Mr. Rawlinson in his paper of 'Instructions and Suggestions to Local Surveyors with respect to Main Sewers, Drains, and Waterworks.' "House-drains," says Mr. Rawlinson, "sink-pipes, and soil-pipes, should have means of external ventilation. Down-spouts may be used for ventilation, care being taken that the head of such spout is not near a window. Inlets to all pipe-drains should be properly protected. Water-closets, if fixed within houses and having no means of direct daylight and external air ventilation, are liable to become nuisances, and may be injurious to health. Water-closets should have a daylight window, not a 'borrowed light,' and fixed means of ventilation which can neither be seen nor tampered with. Permanent openings, equal to a slit twelve inches in length and one inch wide, should be provided."

If these rules and regulations are disobeyed, the house of the richest man in the country may be made, as we know such houses have not rarely been made, as fertile of fever as the most wretched of our town or even of our village alleys. Defective "house-work" of this kind, at Croydon, has been shown by Dr A. Carpenter* to have been the true cause of such unhealthiness as has recently prevailed there; and the carelessness of the owners of house-property, as to carrying on their private works in a safe manner and upon correct scientific principles, has thus cast an undeserved doubt on the general results of the Croydon sanitarian works, which the gentleman just quoted says, have been "eminently successful," whilst those of the irrigation have been "marvellously so." And just as the rich man can make his private house poisonous, so the lodging-house keeper, by the like means can, and often does, make the atmosphere of his hired apartments as depressing and even dangerous to the health of the jaded holiday-maker, as the confined air of his chambers or office had become. The indoors arrangements, or rather misarrangements, of a house situated in the most salubrious of localities may neutralize all the advantages of outer nature, and the weary man may find that he is, at the end of his month's vacation, as poor in health as he was at its beginning—*magnas inter opes inops*.

If the water-closet system is fraught with such dangers to those who, *ex hypothesi*, have the power of taking care of themselves, it may seem to be rash to recommend its introduction among the lower grades of society. But, just as we should recommend the retention (which, indeed, needs no such recommendation) of this system amongst the upper classes, but should imperatively urge the adoption in all cases of the precautions above specified, so, for the poorer part of our population, we believe that the water-closet system, at all events under that particular modification of the ordinary arrangement known as the "Latrine," is, after all, the best also. For full details and figures of the different forms of latrine, we refer to the excellent 'Report of the Commission for the Improvement of Barracks and Hospitals,' at p. 87; but the general statement of the relative merits of the latrine and the water-closet which the Commissioners give we will herewith quote:—"Water latrines," they say, "are preferable to soil-pans," *i.e.* water-closets, "because they are not open to the same objections. They can be made to consume a very small amount of water; they cannot be injured by any ordinary force; they are simple in construction, require very little repair, and are easily kept clean. There are various forms of these latrines in use, but the principle of construction is the same in all. It consists in placing a water-trough under the seating, which is filled to a certain depth with water, and

* 'Times,' December 19, 1865, and the 'Croydon Chronicle,' January 20, 1866; and a pamphlet by Dr. Westall, 'On the Advantages to be derived from the Adoption of the Local Government Act as exemplified at Croydon.' Ridgways, London, 1865.

discharged into the sewer or drain once a day at least. The whole process is simple and efficient, is attended with very little nuisance, and is perfectly innocuous to health. The different forms of latrine vary in construction and in adaptation to their object." The introduction of this modification of the water-closet system into our over-crowded alleys would be a boon indeed; and its machinery, in all its varieties, is, or can be made, so simple that it is less liable to derangement, and consequent pestiferousness, than almost any other structure intended for the same purposes.*

Mr. W. Bridges Adams, indeed, is wellnigh, if not quite, the only engineer of note now living who would demur to Mr. Bazalgette's dictum that "the rapid and continuous removal of town refuse by water is the best and cheapest mode of cleansing populous towns and cities," and who would consequently disapprove alike of water-closet and latrine. In a letter which recently appeared in the 'Times,' Mr. Bridges Adams writes thus:—"Those who have thought deeply on the subject, and thoroughly recognize the utility of the labours of Mr. Bazalgette, as applied to the present time, do not believe that water in rivers, or elsewhere, was intended by Providence to be a carrier of filth for all time. They believe that a noxious substance like the exuviæ of plants or animals is rendered more noxious by being mixed with water, and that until it can be buried underground for the purposes of manure, it is better to keep it as dry as possible, and that the transit will thus be rendered cheaper and less wasteful. When the time shall come for this perception to be common, the chemical and mechanical practicability will not be lacking, and we shall be no longer under the necessity of resorting to water gravitation to help our laziness, in polluting every channel in the land which has a downward slope into the sea." On the other hand, besides the Mayor of Coventry and the enormous majority of professional engineers, we have Mr. Rawlinson speaking unreservedly in favour of the water-closet system, and saying what it is interesting to know with reference to the introduction of this system among the poor, that it is possible to have a town, such as Alnwick, so "completely water-closeted," that "the very beggars' common lodging-houses have water-closets or soil-pans."†

The laws which govern the flow of fluids in pipes and in open channels have attained that mathematical precision and accuracy which renders discussion of them uninteresting and superfluous. Full details as to the size, and shape, and fall of sewers, and the quantity and velocity of their contents may be found in a paper by Mr. Bazalgette, already referred to ('Proc. Inst. Civil

* See Dr. Williamson: 'Edinburgh Monthly Medical Journal,' Feb., 1866, p. 699. "One means of cleanliness should be employed by the poor in common with the rich, and that is, the existence of water-closets in their houses." Dr. Williamson is well acquainted with the poor, being one of the oldest parochial surgeons in Scotland.

† Evidence before Lord Robert Montagu's Committee, p. 186 (4,216).

Engineers,' vol. xxiv. Session 1864–1865), and also in Dr. Parkes's 'Practical Hygiene,' p. 306, and we pass *per saltum*, therefore, from the consideration of sewage at its source and in its place of production, to the consideration of its ultimate disposal and destination, remarking, in so passing, that sewers and main drains need ventilation as much as sink pipes and house drains; and that though tall chimneys, such as those of furnaces and factories as now employed at Woolwich, or other tall vertical tubes, as recently, at Malta, may help in doing this, it is better to reduce the need for it within the narrowest limits, by securing that rapid and constant flow of water through the sewers which will prevent the generation of foul gases within them.

Entering now upon the debateable ground of the disposal of sewage, we shall keep before our eyes the aphorism, "*Citius emergit veritas ex errore quam ex confusione;*" and feeling ourselves that the dogmatism of one man calls forth the research of another, and so is ultimately profitable to both of them and to others, we beg, at the same time, our readers to consider that if we make categorical statements, we do not impose them as articles of faith, to be required of any man to be believed, but propound them merely and shortly as results to which investigation of the subject has brought us, and may bring them or may not. As it seems to us, then, upon the evidence before us, any town-corporation which could command an acre or so of the lightest and poorest land for the reception in open grips and by gravitation of the sewage of from every fifty to every hundred of its inhabitants, might safely count upon a handsome return, in reduction of their local rates, from the sale of the grass crops they would thus and there raise. But it appears that all these conditions must be present if a pecuniary profit is to be secured, besides and beyond the great negative saving which all such disposal of sewage effects, in the way of prevention of disease. When guano has become scarcer, and the farmer more enlightened, it will be otherwise; but, in the meanwhile, it is easy to see that, in many cases, no adequate supply of land may be cheaply available, or that such as may be so, and may also have the sandy or loamy constitution which fits it for irrigatory purposes, may yet be situated so as to stand in need of an expensive lifting and pumping apparatus; or, finally, that the only available area may be an impermeable clay, and thus be physically unfit for the duties which its chemical character would excellently qualify it for. The observation of the great comparative purity of the water which flows out of the thick felt which the American weed forms now in so many of our ditches and sluggish streams, has suggested to us that, in such unfortunate cases as those we have just specified, arrangements might be made for sending the sewage of towns through a network of ditches filled with this vegetable filter. The growing vegetation, besides setting free into the foul water an abundance of purifying oxygen, would build up into its own substance a quantity of valuable manurial salts, which would make it worth the farmer's while to dredge it up and plough it into his land. The positive return from such a harvest as this would be small indeed as compared with that of the Italian or other grass from the meadow, which, in such cases, is unattainable *ex hypothesi*. Still, such a plan, if not positively profitable, would at least be negatively so, by destroying the mischievous and morbific properties of the sewage it dealt with; and thus, as, with the exception of vice, nothing is so expensive as disease, it would effect a real economy. We believe that if a sufficient amount of ditch network were employed, the water which would flow out from the further outlet of the maze would be wellnigh as clear and pure as that which has received the orthodox amount of filtration through four feet of soil, prescribed and followed at Croydon. The account recently given to the world by the Metropolitan Main Drainage Committee, of the application of the irrigation system to this place and of its results, we herewith append.

"After Rugby, your Committee visited Croydon, where they found the application of the sewage carried out with far greater completeness. The land treated is immediately adjoining Boddington Park, and consists of 250 acres of loamy soil, running into sand and resting on the chalk. There is a gentle inclination of the service of the whole towards the Wandle, very favourable to the operation to be performed. The sewage is coarsely filtered, and carried by gravitation through an open cut to the edge of the farm; from this cut it is distributed by small grips or drains, and made to overflow by extemporized sluices inserted here and there by the labourers. The population whose excreta flows over this land is about 17,000 in number, from which 3,000 tons per acre per annum are said to be derived; one-tenth of the land is under irrigation at a time, and each acre is under treatment thirty-six days in the year. The sewage takes about five hours in flowing over the land from the time of leaving the inlet; that period is sufficient entirely to deodorize it, and to enable the herbage to abstract from it the fertilizing salts; after the process has been continued two or three days, it flows off nearly tasteless, colourless, and inodorous. The greater portion of the farm is sown with Italian rye-grass, which requires resowing every three years, and appears to produce the largest results; but some parts are still in natural pasture. It is rented by the Croydon Local Board at 4*l*. per acre, and is sub-let to Mr. Marriage at 5*l*. per acre, so that the Local Board obtain an improved rent of 250*l*. per annum, which goes in reduction of their local rates. Your Committee could not ascertain the exact weight of grass produced. It is cut four times a year, and each cutting sells for about 8*l.* per acre; it is used chiefly for stall-feeding dairy cows. The expense of laying out the surface for irrigation was stated to be from 6*l.* to 10*l.* per acre, of which the Local Board paid 4*l.*; the cost of the rough filtration is nearly defrayed by the sale of the deposit, which fetches about 1*s.* 6*d.* per load."

To this we may add that the success of Croydon has been rivalled at Carlisle and Edinburgh; and that in all three of these cases, the soil on to which the sewage has been discharged has been a more or less light loam, or even, as at Craigentinny, barren sand; * and, finally, that from none of these places has any evidence as yet been gathered as to the applicability of sewage to root or grain crops. The history or rather the natural history of Croydon furnishes a curious proof of the thoroughness of the purifying to which sewage is subjected by irrigation. At p. 51 of the Report just quoted we read:—"Before the present arrangements were in force, the Croydon board had to meet numerous law-suits, on account of the pollution of the river by the sewage; but so efficiently is the sewage now purified, that those having the right of fishing in the river have found it worth while to fix gratings to prevent the fish going up the main outfall from the sewage irrigated land." We believe, however, that, though putrid sewage is poisonous under all circumstances, alike to man and beast, perfectly fresh sewage is, even when wholly unfiltered, far from being destructive of fish and of other (especially invertebrate) forms of aquatic life. The pike haunted the mouths of Agrippa's main drains; and a bold explorer may readily satisfy himself of the identity in this respect of the habits of modern English and of ancient Roman fish. Fish thus fed were considered in the time of Juvenal, and may be considered also in ours, as exceedingly proper food for the parasites or hangers-on or henchmen of the rich man; but fat and well-liking though such fish are, we should be sorry to see them set before any other class of the community. They pick out, it is true, from the solid matter of sewage, fragments and particles which would otherwise have to undergo a long series of dismemberments into simpler and simpler compounds, till some kindly vegetable should deign to re-compound them, and they build up these débris at once into their own substance, but this substance or flesh of theirs, we submit, can scarcely seem attractive when its history is considered, and we believe besides that persons who, being superior to prejudices, will venture upon it, will find other than sentimental reasons for abjuring its use.

It is the solids of sewage which, though containing perhaps but a sixth or a seventh part of its valuable elements, make it so difficult to deal with. They cannot be allowed to spread or smear themselves over the vegetable growths, to which either as grass in the

* 'Third Report,' Appendix, p. 199.

meadow or as weeds in the ditch we trust for disinfection, since, besides being thus unsightly and unsavoury to man, they would be injurious and indeed fatal to the plants and their functions. And to pipes and pumping they are as obnoxious as they are to living beings. Filters consequently of one kind or another, either coarse ones of wicker-work, or more complex combinations of sand, gravel, and ashes, alternating with strata of hurdle-work, are employed to free sewage from these troublesome constituents. Of the coarser kind little need be said, beyond suggesting, that a rapid flow of the main drainage contents over an artificially roughened bottom might by the attrition and contrition of the matters referred to, set free at once into solution, or at all events into suspension, much that might otherwise remain for a long time clogging the filtering hurdles and being otherwise offensive and noxious. The more complex kinds are well described and figured both by the Barrack Commissioners ('Report,' p. 86), and by Mr. Menzies (p. 23); and from the latter gentleman we learn the interesting fact, that we owe the suggestion of the principle of upward filtration to the ingenuity and insight of the late Prince Consort. Filters, whether simple or complex, are liable to displacement and derangement by the sudden influx of storm-water, as well as to clogging by any sudden afflux of the solids of sewage; and on these grounds filters, together with filtering beds, should always be provided in duplicate, side by side, as in the figure given by the Barrack Commissioners.

Much of the labour which we should otherwise have had to impose upon ourselves and our readers, in estimating the merits and claims of the several works, the titles of which stand at the head of this article, has been saved to us by the judicious and well-written pamphlet of Dr. Child. The title of his pamphlet is modest, and we can assure all persons who may wish to gain a knowledge of this subject and its literature, on the easy terms of reading an agreeably written tract, that they will find the performance to exceed by much the promise of the title-page.

As it is the fashion in England—a country where the Government makes its presence to be seen and felt in no other ways than by the penny post and the policemen in our streets and areæ—to depreciate and vilipend all else that wears the Government stamp, we ourselves, having, and indeed desiring, no other relation with the Government than that which the former of the two functionaries just specified sets up between us, think it right to set ourselves against the prevailing fashion, and to say something in praise of the much and most unjustly abused Blue Books. We are glad to observe that Dr. Parkes (p. 266 *l. c.*) makes no secret of the extent of his obligations to the Barrack Commissioners of 1861; and, being well able to stand upon his own merits is not niggard in his bestowal of praise on others. In days, however, like these, when praise is not always rightly bestowed, when Dr. Croly writes two octavo volumes of apology for George IV., when Lord Wrottesley would fain reverse Sir Walter Scott's judgment on Dr. Paris's *philisterhaft* 'Biography of Sir Humphry Davy,' and speaks of it in his address to the Royal Society as "a most felicitous instance of a perfect biography," and M. About gives to the world, with his own name appended, a glorification of Prince Jerome Napoleon, we cannot recommend any one to take any panegyric on trust, and we recommend our readers to obtain this same Report* and read it for themselves. It is with a feeling of shame that we recollect that in an English House of Commons objections were raised to the payment of some small salary to one of the authors of this Report, much as, we doubt not, in many a garrison town objections were raised to the carrying out of its recommendations, which have saved and will save to the country hundreds of lives and thousands on thousands of pounds.

Of Dr. Parkes's work on 'Practical Hygiene' we can speak in the very terms which he applies to the Barrack Commissioners' Report, and say that "it is difficult to speak too highly of its excellence." It treats of many subjects besides those treated of by the Commissioners or glanced at in this review; but in all alike, its information, style, and spirit are of the very first order of merit. Biological and hygienic science is advancing rapidly, but it will be long before Dr. Parkes's book is superseded.

Dr. Acland's 'Memoir on the Cholera in Oxford' may serve as a model for the drawing-up the histories of similar visitations. It is marked by the grace and insight of its accomplished author; and giving a picture of the disease at once in its social, its medical, and its statistical aspects, it will furnish every reader with the information which his taste, knowledge, or ignorance may lead him to seek for.

The 'Seventh Report of the Medical Officer of the Privy Council' is a production of great value; but, like Dr. Parkes's book in this particular also, it travels over several topics—that of vaccination, for instance, with which we have no concern here. By a short but excellent Report of Dr. Hunter's, 'On the Alleged Injury from the Sewage Works at Northampton,' in which we find the *vera causa* of the mischief to be, as at Croydon, defective house arrangements, and here, notably, our old enemy, the cesspools, we pass from the hygienics of the entire community to those of the poor exclu-

* This, we should add, from our own experience, is no easy task; the wise regulations of a certain Chancellor of the Exchequer (not the present one) having, we are told, curtailed greatly the number of Blue Books issued and distributed, and expedited greatly their passage into the hands of the waste-paper seller. The taxation, however, of this great country has been relieved by this measure to the extent of several pounds sterling per annum in postage.

sively, as expounded in Dr. Hunter's longer Report contained in the same volume, and already referred to in this review.

We have spent so much time and occupied so much space with what concerns alike rich and poor, whom, Anthropology notwithstanding, we believe to be of the same species, that we cannot here and now dwell, as we could wish, upon the anti-sanitary condition of Lazarus. If the limits of our islands could be expanded consentaneously with the increase of our population, the profession of the political economist and the occupation of the statesman would both alike be gone. But so long as our territory remains inextensile, whilst our people continue to be fruitful and over-replenish it, so long do we remain liable to hear any day the cry of the Hebrew prophet, "Thou has multiplied the people, but not increased the joy," rising into tones articulate and loud enough to alarm the most thoughtless. Whispers and echoes of this cry can be caught at all times by the attentive ear in over-crowded England; the years that are coming upon us may make its notes familiar to all of us. Those who are best acquainted with all the multiform shapes of poverty's degradation, are agreed that physical amelioration must take precedence of all less material improvements; and finding that vice is as surely linked on to filth, in their experience, as cleanliness is bound up with godliness in the proverb, they would agree with us in thinking that the line of reform about which we have here been writing should be entered upon first of all.

The agricultural economist, however, as well as the sanitarian, is concerned in the questions of sewage and sewerage; and whilst the latter will find the works already passed in review to be drawn up more particularly from his own point of view, those which still remain to be noticed, deal mainly, though not exclusively, with the engineering and financial aspect of the matter. The 'Third Report,' indeed, 'of the Commission appointed to inquire into the best Mode of Distributing the Sewage of Towns,' contains almost equal amounts of the discussions, interesting to either class of investigators. Mr. Rawlinson, in a paper occupying some eight pages, divides his most valuable advice pretty impartially between the two classes of claimants for information and direction; whilst a long memorandum on 'The Contamination of the Water of Leith,' by Dr. Stevenson MacAdam, is, as we should expect, more specially sanitarian. The description Dr. MacAdam gives, at p. 36, of the intimate relations which prevail in Scotland in "the non-drainage localities"—*i.e.*, "in the smaller towns and villages,"—between the cesspools and the wells cannot fail to be interesting, and, indeed, something more than interesting, to the tourist who contemplates visiting that romantic but somewhat uncleanly country. The names of Lord Essex, Mr. Lawes, and Professor Way (the two latter of whom, by the way, pledge themselves, at p. 80, to 5,000 tons of sewage as being the proper annual quantity for properly selected grass land) guarantee the value of the bulk of this octavo, which treats of matters more purely agricultural and economical. It should be added, that no one can be held to have thoroughly mastered this subject who has not read the two Reports preceding the one which we have just noticed, as well as the two others, drawn up by Dr. Brady's Committee, which preceded the one to which we are now about to draw the attention of our readers.

This last and largest of our Blue Books, the 'Report, with Appendices, of Lord Robert Montagu's Committee,' is a vast volume, such as might have been presented to both Houses of the Brobdignagian Parliament by the order of the king of that realm. Partly owing to the demand which existed for this Report, and partly, we imagine, owing to the wise regulations for the "happy despatch" of Blue Books, to which we have already alluded in a note, this gigantic Blue Book is not, we apprehend, procurable by ordinary mortals. The Report (under which word we have elsewhere in this article, for brevity's sake, included Report and Appendices) itself is but short; and its salient points are easily reproducible, but that the evidence given, and the applications and tenders made, to the Commissioners and the Board of Works, in every style and by men of every class—from men decorated with the Victoria Cross down to men who accuse their rivals of being "Irish solicitors, struck off the rolls 'for a cause,'"—should be lost to the world, is a thing to be regretted on every ground, scientific, literary, and social.

Mr. Menzies's book possesses great claims, both extrinsic and intrinsic. It is printed and got up in a style *de luxe;* and the matter which it contains is so clearly and pleasantly put forth, that the mind has as little difficulty in apprehending the writer's meaning, as the eye has in running along his liberally-interspaced, liberally-margined lines. Mr. Menzies's views are generally, as it seems to us, sound, and in keeping with those entertained by the majority of the engineering profession; and we do not know that, for the beginner, a better introduction to the subject can be found than that which this book affords. It is right, however, to add that his views, very fully expounded in his work, as to having separate systems of sewers for the rainfall and for the sewage severally, are in direct opposition to the *dicta* of Mr. Austin, put out in 1857, as well as to those of Mr. Bazalgette, put out in 1866. Though we are by no means disposed to consider the alliterative *dictum,* "the rainfall to the river, the sewage to the soil," as an axiomatic truth, we may grant, towards the end of an article, that the question does admit of two opinions being held about it. Of this, however, Mr. Menzies's suggestion as to "destroying ammonia and other salts" of sewage "entirely," "by passing the whole through filters of *magnetic carbide of iron,*" does not admit; and agreeing with Mr. Menzies as to our need of "further researches from our chemists in this direction," we recommend him, *en attendant*, to expunge this sentence from the proofs of his second edition. Mr. Menzies's remarks as to the impossibility of merely local authorities making even industries, such as those of the water-mill and the river-dock, reduced though they are to insignificance by the development of the steam-engine and the railway, subservient to the interests of an entire river valley and its inhabitants, deserve serious attention. A Metropolitan Board, charged with the supervision of our rivers, would raise the temperature and increase the comfort and salubrity of whole counties; and to the establishment of some such agency, strong enough to tax equitably the claims for compensation which local interests will make, and to prevent provincial jobbery, we look forward with confident hope.

Carbolic acid is, according to Mr. Menzies (p. 35), not so favourable to vegetation as Mr. Macdougall has found it at Carlisle; and though he agrees with Professor Way* as to the fertilizing effects of the detritus of the streets upon sandy soils, we observe that his (possibly greater) knowledge of the character and composition of the Edinburgh paving furnishes him with a somewhat different explanation of its *modus operandi* there. It is assuredly a curious correlation—rather should we call it a providential arrangement—that where men congregate in great numbers, the refuse from their gas manufacture should furnish them with such a disinfectant as is carbolic acid; and that the very washings of the streets, worn into powder by passing and repassing wheels and feet, should render the barren sand capable of cultivation.

Of the ultimate triumph of the sanitarian creed, we will say, in conclusion, we entertain not the slightest doubt. Unbelievers will be converted and nuisances reformed; our houses will be made wholesome, our streets inoffensive, and our rivers pure. The strength of those who work, whether by head or with hand, will be less encroached upon by debility and depression; and the sum total of our years, and even of our happiness and enjoyment, will be increased perceptibly. Something, however, may be done to retard the consummation of the sanitarian victory, by the incautiousness of the sanitarians themselves. The best cause is injured by an over-statement, and the following assertion, at p. 179 of the evidence given before Lord Robert Montagu's Committee, partakes somewhat of the character of an over-statement. The witness whose evidence is there recorded, speaks to the following effect:—"My experience is, that if you compel the detention of the refuse of cess-pools in the vicinity of human dwellings until putrescence has set in, you as certainly manufacture fever as two and two make four." Now, we do think it highly probable that accumulations of festering

* Professor Way: Evidence Lord R. Montagu's Committee, p. 214.

filth may, under certain conditions, actually generate fever, without the entrance of any such fresh agent as a "specific cause" from without; but between being "highly probable," and "as certain as that two and two make four," there is a good deal of difference. The fact is, that the question of the spontaneous generation of fevers is, like the yet larger question of the spontaneous generation of organic living forms, still a moot point, though it cannot be said in this, as in the larger question, that the "Panspermist" has the weight of authority on *his* side. In a thickly-populated country like ours, it must always be possible for the seeds of any disease to be carried any whither; and a "Panspermist" ought not to be less vigilant in rooting up what, on his view, would be the necessary *nidus* for his *germs*, than the man who believes, as we incline to believe, that the "*nidus*" itself can produce the eggs. The question, therefore, is not necessarily a practical one; there are diseases enough which have their parentage referred, by all but bad landlords, to bad drainage, and with Dr. Parkes's well-balanced statement of the case we close it. At p. 28 he says, "To sum up: the diseases produced by fœcal emanations on the general population seem to be diarrhœa; bilious disorders, often with febrile symptoms; dyspepsia; general malaise and anemia—all these being affections of digestion or sanguification; *typhoid fever also is intimately connected with sewage emanations, either being their direct result, or, more probably, being caused by specific products being mixed with the sewage.* In addition, sewer-air aggravates most decidedly the severity of all the exanthemata, erysipelas, hospital gangrene, and puerperal fever, and probably has an injurious effect on all other cases." On the other hand, recent inquiries have shown that certain so-called "facts" alleged by the anti-sanitarians are, in reality, no facts at all. It has been said by these lovers of darkness, that workmen in sewers are not more subject to fevers than other labourers; but on close analysis it has been shown—first, that these men really are less healthy than their brother operatives; and, secondly, that no account had been taken in the examination and enumeration of healthy sewer-men of the protecting influence which previous unrecorded or unrecognized attacks of fever had conferred upon them; and, lastly, that no set-off had been allowed for the working of natural selection, in weeding-out, at their very first entrance upon the employment, of such would-be sewer-men as had no innate aptitude for the function.

There is a fault of minor importance, in a scientific point of view, but still of much practical moment, into which several sanitarians have fallen, and which all would do well henceforward to avoid. This fault is a fault of style, and consists in the introduction of rhetorical language, of far-fetched metaphors, and even of sacred names into the somewhat earthy matters of which we have been writing. The man of science recognizes such merit as the evidence may possess, in spite of the masquerading dress it wears—the man of business is prone to turn a deaf ear to it altogether, because of this disguise and disfigurement. The former looks upon such an exhibition as something analogous to the aberrations of form which under certain circumstances beset the crystallization of certain salts, and the grotesqueness of the form assumed blinds him in neither case to the real nature of the substance before him. It is the sweeping style just now mentioned to which he objects, as he judges by sense and not by sound, whereas it is the stilted style which is an abomination to the chairman of a Parliamentary Committee, and may cost the cause which is advocated in it his help, his influence, and his vote.

IV. ON THE ANTIQUITY OF THE VOLCANOS OF AUVERGNE.

By Charles Daubeny, M.D., F.R.S., Professor of Botany at the University of Oxford.

(*Illustrated.*)

Accustomed, as we are, from our earliest infancy to have the first elementary truths of astronomy instilled into our minds, we can scarcely realize the idea, that nations, even in an advanced state of mental progress, were in the habit of viewing our relations to the celestial bodies around us in quite a different light from that in which they present themselves to us at the present time.

Almost every child who has had a few months' instruction in a parish school knows, that the earth turns round the sun, that the circle which bounds our horizon is not the limit of the universe, that the moon revolves in an orbit, which, although unapproachable by us from its distance alone, is near in comparison with the space which divides us from the sun, and yet that this great luminary is placed, as it were, within our own immediate neighbourhood, as compared with the distance which separates us from even the nearest of the fixed stars.

But these persuasions have grown up within a very recent period, and are due to the slow infiltration of philosophic truths into the minds of the vulgar, gradually displacing the earlier notions which had been acquired through the apparent testimony of our senses.

In the most flourishing periods of ancient Greece and Rome, in mediæval times, and even in ages approaching to our own, the same belief did not exist; nor, indeed, was a knowledge on such subjects a part of what the Almighty thought fit to impart by supernatural means to his chosen people.

Now, when it required so many centuries of research to indoctrinate the public mind in more enlarged ideas as to space, it cannot be a matter of surprise that geology, a science of much more recent date than astronomy, should not yet have succeeded in instilling more correct notions as to the extent of past time.

Without going back to times when this science was so much in its infancy, and was so little listened to out of doors, that the great body of the laity, as well as of the clergy, imagined the earth, as well as all the other celestial bodies, to have been called into existence by the direct *fiat* of the Almighty within the space of six literal days; and when it was taken for granted that the period which had elapsed since the creation of the universe was comprehended within the 6,000 years which, according to Archbishop Usher's calculations, had elapsed since the birth of Adam, I can myself recollect when geologists of reputation, whilst contending that the days of creation must have embraced an extended duration, rather than a compass merely of twenty-four hours, took it for granted, nevertheless, that the latest epoch in the history of our planet—namely, that during which the climate and configuration of the earth's surface corresponded in its general features with those it exhibits at present—was ushered in by the appearance of man upon the globe, and consequently could not be traced back to an earlier date than that which on Scripture authority had been assigned for the first introduction of our species.

Upon the subject of man's antiquity I shall not enter; but with regard to that of the earth itself I may remark, that subsequent investigations have compelled us to enlarge very materially the allowance of time formerly allotted for its formation. They have shown us at least that if what is called the post-pleiocene epoch is to be estimated as dating its commencement from the setting in of that intense cold which characterizes what is called the glacial period, if to a temperature such as allowed of the growth of subtropical plants had succeeded in the same latitudes as those of our own island, one as rigorous as that of Labrador at present, and if afterwards a gradual change supervened, by which the climate came by degrees to be assimilated to what we experience at present, a longer interval must be supposed, than our received systems of chronology, built upon the assumption that man was a denizen of the earth throughout the whole of that period, would allow us to recognize.

And yet the time taken up in this the latest of the world's stages of progress, if I may so express myself, may bear no larger proportion to that occupied by the whole series of formations from the first dawn of organic life upon the globe to the present time, than the distance in space between us and the moon bears to that which intervenes between our planet and the sun; just as even the time taken up by the deposition of all the rock formations, collectively considered, shrinks as much into insignificance by the side of that required, according to the computation of mathematicians, for the cooling down of the earth from its original vaporous or incandescent condition, to a temperature such as admitted of the existence of life, as the distance between ourselves and the sun does to that which divides this luminary from the nearest of the fixed stars.

Thus, let us call the circumference of the globe, 1.	And, calling the distance from the present time to the birth of Adam, 1.
Then the distance from the earth to the moon will be 10.	The distance from the same to the commencement of the post-pleiocene epoch would be 10.
Distance from the earth to the sun, 400.	Distance in time from the commencement of the post-pleiocene epoch to that at which organic life began would be 400.
Distance from the sun to the nearest of the fixed stars (*viz.* 61 Cygni) will be 160,000.	Distance in time from the commencement of organic life to the period when the earth was first created, would be 160,000.

I have been led to these general remarks by the subject which has been proposed for the present communication, in which it will be attempted to show that the phenomena presented by the extinct volcanos of Auvergne tend in a very marked manner to corroborate the inferences which, on other grounds, I have deduced with regard to the long space of time that must have been consumed even by that one stage in the earth's history which connects itself most nearly with the present, not to speak of that almost interminable series of antecedent deposits which contribute to make up the entire crust of the globe.

In order to render this subject more intelligible, it will be necessary for me to enter into some details, which may appear to some rather egotistical, as they will involve an account of my earliest visit to Auvergne, which took place in 1819, before any other British geologist, since the peace with France, had explored the district.

I had come at that time fresh from the lecture-room of Professor Jameson, of Edinburgh, who was regarded a great authority in Geology, partly from the accurate knowledge he possessed of the characteristics of rocks and minerals, and partly as being one of the very few of our countrymen who had studied under Werner, the great Freyburg Professor, whose opinions respecting the structure and formation of the globe gave the law at that time to all who had studied under him.

Although in the lore which he had imported from his German master there was no small admixture of hypothesis, and that, as we now conceive, of a very crude and gratuitous character, yet the Professor contrived to impress his pupils with a high idea of the soundness of his instructions, not only for the reasons already assigned, but also from his dry and didactic manner, which seemed to preclude the notion of anything like fancy or imagination intermingling in the circle of his ideas. Coming forward indeed as the British representative of the Wernerian School of Geology, he felt it incumbent upon him in his lectures to exhibit the greatest possible antagonism to the treatises of Hutton, Playfair, and others of his countrymen who had appealed to Vulcan and Pluto as the main Artificers in the formation of the globe. With this view he founded, in opposition to the Royal Society of Edinburgh, where the Huttonian theory maintained its ascendancy, a new one, consisting chiefly of his own friends and adherents, which was denominated the Wernerian; and in order to render more patent the contrast between his mode of teaching and that of his opponents, he adopted the term Geognosy instead of that of Geology, by way of implying that his views were based upon observation, whilst theirs had drawn largely from the regions of imagination.

Now Werner had carried the Neptunian theory, as it was called, to such an extent, as to regard as deposited from aqueous solution, not only granite, but even basalt and traps of every form and description; and inasmuch as in Saxony from whence his observations were chiefly derived, the trappean rocks occur in vast tabular masses overlying the other strata, he imagined the former to have been deposited in consequence of a great inroad over the land, of water, carrying with it in solution the materials of which these rocks consist, so that the retiring flood left behind it on the summits of the highest ground it had reached those great deposits of trap which are found at this elevation.

And Werner's disciple, Professor Jameson, so far conformed to the creed of his master, that he stoutly maintained the aqueous origin also of all those formations of trap and porphyry which assume such gigantic proportions in various parts of Scotland, in the Hebrides, and in the north of Ireland.

In spite of the striking contrast which these rocks in their lithological characters present to ordinary deposits from water; in spite of the resemblance they bear to the products of fire; in spite of their intrusion into other strata in a manner which conveyed the idea of their former liquidity; and in spite even of the changes they often appear to have wrought upon the beds in contact, indicative, as it would seem, of fusion, Professor Jameson persuaded his pupils that the Wernerian theory was to be extended to them as well as to the rest.

But Auvergne, a region which had been already explored by

Von Buch, then a young and rising geologist of the school of Werner, exhibited phenomena which seemed to many of us scarcely reconcilable with this conclusion; for whilst we were told of rocks existing in that district which were scarcely distinguishable from the traps of Scotland, we learnt on the other hand, that these same formations were found in intimate connection with craters of extinct volcanos and with the scoriæ ejected from them, forming even a part of the streams of lava which had descended from these igneous vents.

In undertaking, then, a journey through Auvergne, one especial object I had in view was, to see how far I could reconcile the Wernerian doctrine, which had been instilled into me by my late preceptor, with the facts that had come to my knowledge with reference to this particular district.

But although I started on my expedition just after I had been sitting at the feet of my Scotch Gamaliel, I had also in previous years derived instruction in geology from quite a different kind of teacher, having attended the lectures of Professor Buckland, at Oxford, which, although not professedly antagonistic to those of Jameson, exhibited the subject under quite a different aspect, both from his mode of treating it, and from the opposite character of his mental constitution.

Whilst Professor Jameson confined himself for the most part to a description of the older rocks, and considered them chiefly with reference to their lithological characters, Professor Buckland drew his illustrations chiefly from the modern, as his main interest lay in tracing the successive revolutions which the earth had undergone, as determined by the changes in organic loss revealed to us by their petrifactions, as well as by the erosion of valleys, the transportation of erratic blocks, and the dispersion of gravel over the low ground.

Amongst the many catastrophes which he so vividly depicted, the latest, according to his reckoning, was that Deluge which Holy Writ had recorded, and which, instead of being confined (as many divines at the present day are content to regard it) to those regions which were actually peopled by man, had, as he conceived, left traces of itself in every part of the globe.

Those only who, like myself, can recollect the early lectures he delivered in the old Ashmolean building, to which Academics of all degrees of standing, from the Freshman to the Head of a house, flocked from every College and Hall of the University, can form an idea of the interest he inspired in this new study, by that union of vivid description, extensive knowledge of details, boldness of speculation, drollery, and enthusiasm with which he fascinated the minds of his hearers.

I may observe, however, that not only in those lectures of his which I attended in the years 1815 and 1816, but long subsequently, as in his 'Reliquiæ Diluvianæ' published in 1824, the Professor appealed to the organic remains contained in caves, fissures, and diluvial gravel, and to other phenomena, as attesting the action of an universal deluge.

And such was the influence upon the scientific world which he commanded by the zeal, eloquence, and research which he displayed in carrying out his favourite hypothesis, that diluvial action, diluvial gravel, diluvial pebbles, diluvial detritus, and the like were for many years received amongst the household words of geologists both in England and on the Continent.

It is true, that the scientific evidence by which he supported the notion of an universal deluge broke down upon further inquiry, and thus an early lesson was afforded us of the imprudence of pressing hastily into the defence of religion even the most plausible inferences deducible from the facts of science. The risk of thus prejudicing the cause which it was intended to uphold, by the re-action produced upon the mind from the subsequent exposure of the fallacies involved in the argument advanced, has been lately pointed out by Dr. Pusey in his discourse on 'The Relation of Science to Religion,' delivered at the Norwich Church Congress, and will, I believe, meet with general assent amongst men of science as well as theologians of all parties.

Still at the time I first visited Auvergne, the position that the valleys had been excavated by the action of the Noachian deluge reigned undisputed; and thus I began my explorations in that district with a mind prepossessed, not only with the doctrine of the aqueous origin of trap which I had derived from my Edinburgh preceptor, but also with the idea that the valleys in every country were the results of this supposed catastrophe.

It did not require more than a few days' sojourn in Auvergne to disabuse my mind of the former opinion, for the association of rocks undistinguishable from the traps and porphyries of Scotland, with craters, lava streams, and heaps of scoriæ, which plainly attested the operation of volcanic heat, soon convinced me that the Wernerian doctrine as regarded the origin of basalt was untenable.

But the theoretical views which I imbibed from my Oxford instructor were not so easily got rid of; for the phenomena presented by the volcanos of Auvergne proved of a nature to afford an apparent confirmation of the distinction which Dr. Buckland had set up between rocks formed *before* and *after* the Noachian deluge, or, according to his nomenclature, those of ante-diluvial and post-diluvial origin.

The volcanic rocks which we observe in this part of Central France may be separated into two classes, both by the difference in their external characters, and also by their position with reference to the surrounding strata.

The first class consists of those which have been cut through by the existing valleys like the other rocks of the district; the second, of those which follow the inequalities of the surface, so as to prove that they were ejected since the country had acquired its present configuration in all its important features.

Subsequent observations have, indeed, shown that no sharp line of demarcation exists between the two, as there are instances of volcanic rocks which, although they have descended the slope of a valley, were themselves scooped out to a great depth by the same agency. But that the distinction can be clearly traced in many instances cannot, I think, be disputed by any who have visited the locality.

Moreover, a great difference exists between the two classes in their external characters, the former possessing in general the compactness and stony aspect belonging to trap and prophyry, the latter that cellular, glassy appearance and harsh feel which characterize modern lavas.

The former accordingly support a luxuriant vegetation, whilst the latter are scarcely decomposed by time, and therefore afford but little pasturage, and that generally of the worst description. The former, too, constitute extensive sheets of rock spreading over large districts, and cannot be traced to any point of issue, whereas the latter may generally be found to emanate from a crater, from which they proceed into the lowest ground contiguous, in a stream, the breadth of which bears no proportion to its length.

In accordance, then, with the views prevalent at the time I first visited the country, the former class would be entitled to the name of ante-diluvial, and the latter to that of post-diluvial, the one being regarded as produced before the great catastrophe by which the valleys of the country were then conceived to have been excavated, the latter subsequently to that event.

It therefore became a question of some interest to determine whether any records existed which should indicate the continuance of the activity of the Auvergne volcanos down to the period of authentic history. But on this point classical authorities are silent.

Julius Cæsar, by no means inattentive to the external features of the countries he invaded, makes no allusion to any volcanic phenomenon having arrested his notice, although he encamped upon the plains of Auvergne, and laid siege to Gergovia, the principal city in the district.

His silence, however, it may be said, only proves that during the period at which he was engaged in that part of Gaul the igneous forces were slumbering, as might have happened in the case of Etna or Vesuvius during any such short interval of time.

But what shall we say of the omission of Pliny to include Auvergne amongst the regions in which he records the existence of fiery mountains; and what of the silence of Strabo on the same point? to say nothing of the poets, who indulge in such frequent mention of Etna and Lipari, but make no allusion to volcanos in other portions of the then known globe.

And yet of all natural phenomena a burning mountain is the one which in all ages most forcibly rivets the attention of the multitude, and of which the memory is longest retained by tradition, or by means of the popular fables engrafted upon it.

The volcanic fire once raging near Lemnos, about Santorino, in Argolis, and elsewhere, is made the subject of many a poetic legend, and even less formidable phenomena of the same kind, such as the bursting forth of flames from the ground, are carefully recorded by the naturalists of Greece and Rome.

The most convincing proof, however, that the volcanos of Central France were not in activity so late at least as the fourth century of the Christian era, or at any period antecedent to this, which would be included within the range comprised by the histories or the traditions of the country, is afforded by the absence of all allusion to such phenomena in the existing works of Sidonius Apollinaris.

We learn from some of his writings which have come down to us, that he had a palace on the borders of Lake Aidat, in the very midst of the volcanic region alluded to. In one of his poems he celebrates the beauties of this residence, and compares it to his former abode at Baiæ, near Naples; but not a hint escapes him that he had ever witnessed or even heard of any volcanic eruption in his neighbourhood, although he must have been familiar with the nature of such phenomena, from having previously resided in the neighbourhood of Vesuvius.

And yet the very lake near which his episcopal palace stood, owed its origin to one of the more recent, or, according to Dr. Buckland's hypothesis, of the post-diluvial eruptions, one which, invading the bed of the little River Sioule, by the stream of lava it sent out, raised a barrier across it, and ponded up its waters, until they accumulated to such an extent as to form a considerable sheet of water.

It was on these grounds that in the account I published in 1819 of this my earliest visit to Auvergne, I concluded that although some of the volcanos of this country might have been in activity since the epoch of the Noachian deluge, they must all have been extinct before the Roman invasion; and this conclusion was assented to by Mr. Scrope, Sir Charles Lyell, and other geologists, who afterwards explored the district.

Nevertheless, in the year 1844, a different view of the subject was advanced by an eminent historian and antiquary, Sir Francis Palgrave, who, in an article "On the Norman Conquest," in the 'Quarterly Review,' endeavoured to show by some quotations from the writings of Sidonius Apollinaris, and of Alcimus Avitus, Bishop of Vienne, that the volcanos of Auvergne had been in activity so late as the fourth century after Christ.*

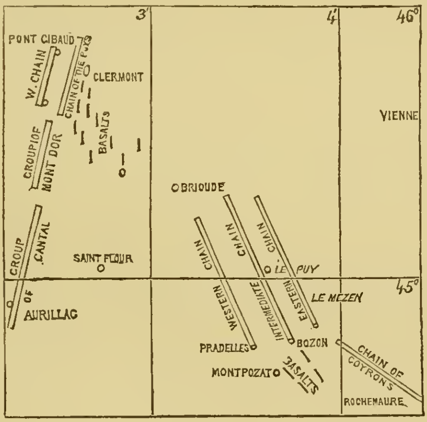
* Reference was made to Sidonii Apollinaris, Epist. 1; and Alcimi Aviti 'Homiliæ de Rogationibus.'

In reply to the arguments he advanced, I observed,* that although some of the expressions of Sidonius and of Alcimus Avitus quoted might seem at first sight to refer to a volcanic eruption, yet the following considerations would forbid of our entertaining such an hypothesis.

1. The city of Vienne, near which the physical convulsions alluded to were reported to have occurred, lies nearly seventy miles in a direct line from the theatre of volcanic action situated round Clermont.

The relative position of the city of Vienne to the nearest volcanic chain is shown in the accompanying diagram.

FIG. 1.



2. Had Sidonius ever heard of such events occurring in his own neighbourhood, he would scarcely have failed to refer to them, if not on other occasions, at least on this, in which he vividly depicts the alarming catastrophes that had occurred in a neighbouring province.

3. The city of Vienne stands upon gneiss, with the great coal formation of St. Etienne interposed between it and the rocks of Auvergne, and with a range of hills of considerable elevation intervening between the two.

4. The geology of France has been carefully explored by the labours of Elie de Beaumont and others; but no notice of anything volcanic in the vicinity of Vienne can anywhere be found in their descriptions.

5. No volcano could have burst out without leaving permanent traces of its occurrence in the craters and lava-streams which it must have produced.

* See my work, entitled 'Descriptions of Volcanos.' Taylor & Francis, 2nd ed., 1848, p. 31.

6. It is contrary to the analogy of other active volcanos, to suppose that an eruption should have broken out at such a distance from the sea as that at which the city of Vienne is situated.

7. Allowance being made for some little exaggeration in this part of the narrators, the descriptions both of Sidonius and of Avitus might apply to those dreadful earthquakes which, as we have reason to believe, from the subsequent testimony of Gregory of Tours, ravaged the whole of this district, and which may easily be supposed to have extended from the former seat of volcanic activity, in Auvergne, to a neighbouring province, just as the most fearful earthquakes in Sicily are experienced, not at Catania, but at spots as far distant from Etna as Palermo.

The underground thunder, the opening of fissures in the ground, the bursting-out of flames and gases, the projection of water and of stones, the smell of sulphur, the alarm evinced by the animals of the spot and neighbourhood, the elevation or depression of the land, noticed by Sidonius and by Avitus in the passages referred to by Sir Francis Palgrave, are all reported as concomitants of the great earthquakes which have occurred in more recent times.

On the above grounds I continued sceptical as to the late date assigned to the volcanos of Central France, even after weighing the arguments which Sir Francis Palgrave had brought forward in support of his opinion; and as this distinguished writer never appears to have replied to my arguments (although in his 'History of Normandy,' published in 1856, he briefly reiterates his statement, without, however, remarking upon the grounds which had led him to adhere to it), I considered the question to be set at rest, until last year, when the controversy between Bishop Colenso and his antagonists, relating to the accuracy of the historical portions of the Pentateuch, unexpectedly led to its revival.

The Bishop, it seems, contended, that if the deluge recorded in Genesis had been universal, it must have swept away those cones of loose scoriæ which are found in many parts of Auvergne, the great antiquity of which he inferred, amongst other reasons, from the admitted fact, that all volcanic action had ceased in the country before history commenced.

To this his opponents replied, by appealing to the evidence already got together by Sir Francis Palgrave, in proof that such operations had continued there as late as the fourth century after Christ.

Now, with reference to the question at issue between the Bishop of Natal and his opponents, it seems to me to matter little which side of the controversy is espoused; for, on the one hand, supposing it to be established that the volcanos of Auvergne had continued active as late as Sir Francis Palgrave imagined, it would still remain to be ascertained whether those particular outbreaks to which Colenso had appealed could be referred to a date subsequent to the Noachian deluge.

And on the other hand, supposing it probable that all traces of igneous operations had ceased before the earliest period to which history points, there would still be an ample margin left between that and the supposed date of the Flood, to allow of these outbreaks having taken place.

Let us, then, enter upon the inquiry with minds unswayed by any theological bias, and simply consider whether it be probable that, in the passages above alluded to, anything of the nature of a volcanic eruption could have been intended.

And for my own part, as no new arguments have been advanced in support of those alleged by Sir Francis Palgrave, I feel still at liberty to adhere to the opinion which had been taken up long before its possible bearing upon any polemical question was dreamt of, and to maintain, as I did in the year 1819, that the volcanos of Central France have not been shown, by evidence yet adduced, to have been in activity at any period within the range of history or tradition.

And now, having, as I hope, disposed of this previous question, let us proceed to consider whether that class of volcanos which I denominated *post-diluvial*, but which I shall now merely designate as, by comparison, *modern*, presents any characters indicating great antiquity.

In fixing their age, I have derived great assistance from the researches of those eminent geologists who, since the period of my first visit to Auvergne, had explored the district in question, and especially from those of Mr. Scrope, who appears to have spent there the summer of 1821, and of Sir Roderick Murchison and Sir Charles Lyell, who went through the country in 1828.

From the descriptions given by these and other competent authorities, it plainly appears that the valleys in Auvergne were excavated, not at one, but at several successive periods—or, more correctly speaking, that although water was instrumental in their formation, yet that they must have been scooped out, not by any violent movement or sudden passage of a flood over the country, but by the long-continued action of the rivers now in existence.

And if this be the case, it follows, that there can be no abrupt line of demarcation between the older and the more modern volcanic products, and that even those which have been ejected since the formation of the principal valleys, may nevertheless afford evidence of extreme antiquity.

It is but fair to attribute to Mr. Scrope our first correct notions on this subject.

His 'Memoir on the Geology of Central France,' published in 1827, evinces a just idea of the mode in which its valleys were formed, as well as a clear appreciation of the amount of time which must have been occupied in their excavation, and his Work is illustrated by a number of interesting panoramic views, which bring vividly before us the general Physiognomy of the country, so as better to enable us to realize the force of the evidence he had brought forward.

To this work, and to the memoir of Lyell and Murchison, 'On the Excavation of Valleys, as illustrated by the Volcanic Rocks of Central France,' I am chiefly indebted for the few facts the space allotted me admits of my bringing forward in proof of the great antiquity even of the more modern class of eruptions.

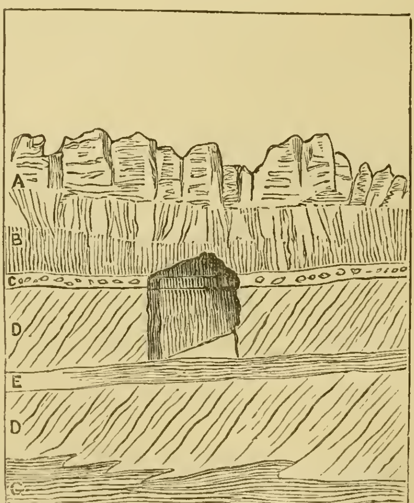
Let us take the case of the volcano of Chaluzet, near the village of Pont Gibaud.

This is a conical hill, composed of red and black scoriæ, having on its summit a depression resembling a worn-down crater, from which may be traced a powerful stream of lava descending into the valley below, in which the river Sioule flows. Deflected to the north-west by the lofty and serrated ridge of gneiss which forms the right bank of the stream, the lava-current follows its course as far as "Les Combres," where it terminates.

The upper portion of the mass is scoriaceous, the lower compact and prismatic, and the under-surface of the prisms stands at a height of about 50 feet above the present bed of the Sioule, resting upon a bed of pebbles.

The pebbles have indeed been traced some way into the rock, in consequence of a gallery driven in horizontally through the upper part of the gneiss and the interposed alluvium, so as to render it clear that the lava-stream really rests upon the latter.

Fig. 2.



A. Scoriaceous Lava. B. Columnar Basalt. C. Bed of Pebbles.
D. Gneiss. E. Path. G. River Sioule.

The annexed drawing, taken from Sir Roderick Murchison and Sir Charles Lyell's paper 'On the Excavation of the Valleys in Auvergne,' will illustrate the relative position of the lava-current and gneiss in this locality.

Hence it follows, that since the period at which the lava was ejected, a thickness of 50 feet of solid gneiss must have been excavated.

Now the slowness with which the present river erodes a material of this description may be estimated by a fact pointed out by Sir Charles Lyell in the same province, near St. Nectaire, where an ancient Roman bridge spans the River Couze, over a stream of lava, proceeding from a volcanic hill,—the Puy de Tartaret,—showing that a ravine, precisely like that now existing, had already been excavated by the river fourteen centuries ago.

And yet the lava of the Puy de Tartaret presents all the appearance of a modern current, both from its having conformed to the sinuosities of the valley, and also from its covering a bone deposit at its bottom, indicating a mammiferous Fauna, which, although distinct, as a whole, from that now inhabiting Auvergne, presents some features in common with it, as in the existence of the dog, deer, cat, &c., mixed with the remains of the reindeer, which, even so late as the time of Cæsar, appears to have been found in the Great Hercynian Forest, and also with an animal of the horse tribe, differing, however, in some points from the species now living.

But it is in the neighbouring province of the Vivarais that the most remarkable instances of the long-continued action of water slowly eroding to a great depth streams of lava which have flowed at a comparatively recent date, are afforded.

Before describing these, however, I must point out a circumstance which distinguishes a current of lava from one of water, namely, that from its viscid character it has a tendency, near its termination, to accumulate layer upon layer, so that its materials are piled up to a considerable height, instead of spreading onwards, as would happen to a substance of more perfect fluidity.

Hence, when a lava stream reached the bed of a river, it sometimes formed a precipitous bank on one side of it, without appearing to have advanced to the other.

Of this, indeed, several examples are met with in Auvergne, but the most remarkable cases are those to which I have alluded in the Vivarais.

In that province, Mr. Scrope enumerates no less than six perfect volcanic cones, with craters on their summits still preserved in a state of greater or lesser integrity, from which have proceeded streams of lava, each of which may be traced down the sides of the mountain, and are seen to terminate abruptly at its foot.

Now, when the bottom of the valley is occupied by running water, its bank is walled in by a colonnade of basalt, extending for a considerable distance along its margin, derived from the lava stream which had descended from the mountain above.

It is true that when, as sometimes happens, the igneous mass is not perceived on the opposite bank of the river, as is the case at the Coupe de Col. d'Aisac, of which a description and drawing has been given by Faujas St. Fond, we have no right, for the reasons above stated, to ascribe the entire height of the vertical cliff of basalt to the eroding force of water; but, in other cases, as at the spot called the Gravenaire of Montpeset, of which Mr. Scrope has given us a drawing, there can be no mistake about the matter, as a high, precipitous rock, upon which the ruins of a castle stand, is severed from the main body of the lava current, and rises up in the midst of the stream. The upper portion of this rock is composed of basaltic lava, derived from the mountain above and forming the termination of a current which had flowed from it; but the lower consists of gneiss, which, since the lava current had been erupted, is seen to have been excavated by the erosive power of the stream to the depth of 100 feet. The time necessary to bring about this effect I will not pretend to estimate, but may appeal to it as a proof of the great antiquity of a lava current, which must have, at least, been antecedent to its commencement.

One very remarkable peculiarity of the lava streams in the Vivarais currents is their basaltic character and their prismatic structure. We are accustomed to consider trap rocks in general, and more especially that particular description which is denominated basalt, as exclusively the product of submarine volcanos, their compactness being said to arise from the great pressure exercised upon them during their consolidation. But in this part of France we meet with several instances of basaltic colonnades, which have been evidently derived from streams of lava ejected from sub-aerial volcanos.

It is true that, in all those specimens which have come under my notice, minute cells and cavities may be discovered by careful examination, and, moreover, that the upper portions of the bed are more pervaded by them than the lower.

Still the resemblance which they bear to the products of submarine volcanos is very remarkable, and only admits of being explained by the thickness of the bed and the weight of the scoriæ superimposed, for it evidently matters not in what way the pressure is produced, provided it be sufficient to retain the aqueous and other volatilizable ingredients present within the rock in such a condition as to prevent the production of cells and cavities.

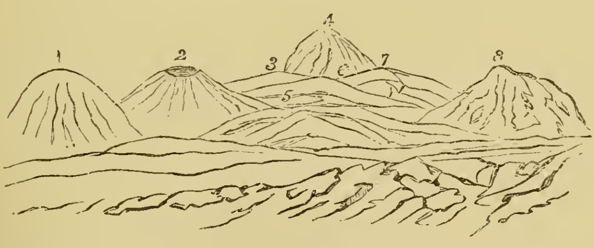
And, accordingly, it is observed, that this compact character and columnar structure are not met with in those parts of the current which occupy the slope of the mountain, but only at its termination in the valley below, and that even there these characters are confined to the lower portions, where the pressure must have been greatest, the basalt being surmounted by a considerable thickness of cellular lava of the usual kind. Moreover, a difference can be traced in the degree of its compactness according to the relative position which the specimen holds in the basaltic bed, the upper layers being the most cellular.

In the Vivarais, then, as well as in Auvergne, we have abundant instances of lava streams, which, although amongst the most recent the district affords, being poured forth at a time when the general configuration of the country had become nearly what it is at present, exhibit, nevertheless, traces of their high antiquity, from having been subjected to the long-continued operation of denuding agents.

Where these agents have been at work their relative date may be fixed, but we do not appear to possess the same means of referring to a particular epoch the five isolated domes of trachyte which occur on the tableland to the west of the city of Clermont, although the occurrence of free muriatic acid in one of them would imply that they were modern.

These conical hills, of which the loftiest, called the Puy de Dôme, rises to the height of 4,842 feet, or 3,554 feet above the level of Clermont, seem each to have proceeded out of the midst of a kind of crater formed by volcanic rocks of the usual character and appearance, and therefore bearing no analogy to the material of which they are themselves principally constituted. Their general appearance is represented in the annexed woodcut, from a drawing of Scrope's.

Fig. 3.



They seem to bear some resemblance, although on a much larger scale, to the Bosses or *Mamelons*, to use a French phrase, protruding from the midst of the craters of Rocca Monfina, near Terracina, and of Astroni, near Naples, which may perhaps be paralleled by those dark spots observed by astronomers in the midst of the circular hollows existing on the surface of the moon, which Sir John Herschel and others have regarded as volcanic craters. Without discussing the mode of their formation, which would detain us too long, it may be enough to say that they would seem to be more modern than the amphitheatre of volcanic rocks which encompasses them, though their elevation, which places them far beyond the reach of the eroding action of rivers, prevents our fixing with any certainty the degree of their antiquity.

Let us therefore pass from these problematical rocks to others of far greater antiquity than any that have yet come before us.

They may be divided into two classes—namely, those of a basaltic and of a trachytic character, and of these the latter seem in general to lie lowest, having the basaltic superimposed.

But since the trachyte at the same time rises to the most elevated points in the country, as at the Pic de Sancy, near the Baths of Mont Dor, where it attains the height of 6,217 feet above the sea, and in the neighbouring department of Cantal, where it reaches, at the summit of the Plomb de Cantal, that of 6,096, the basalt seems in some places to lie beneath it.

Although volcanic, these rocks bear but a remote resemblance to the rocks above alluded to; for not only are the materials of which they are composed in general more compact, but when scoriform, they consist for the most part of pumice, a material not met with, it is believed, amongst the more recent class of volcanos.

Still more distinct, too, is their general structure; for, instead of constituting streams of lava traceable for the most part to a crater as their point of issue, they are spread out into vast sheets, extending continuously over wide areas, in some places indeed rising to a great elevation, but even then exhibiting no traces of anything which bears the slightest resemblance to a crater.

Indeed, so contrasted are the general characters of the volcanic rocks we are considering, with those in the neighbourhood of Clermont, that Messrs. Dufrenoy and Elie de Beaumont, the French geologists alluded to, conceived that their structure may be best explained upon the supposition, that they had been first spread almost horizontally over the surface of the subjacent gravel, and afterwards were upheaved at three different points, the Pic de Sancy being the centre of one elevatory movement, Roche Sanadoire of a second, and the Puy de la Tache of a third, these representing the highest spots in the vicinity of the Baths of Mont Dor, around which the supposed elevatory movement took place.

Now the deep valley in which these Baths lie is conceived by these same geologists to have been originally formed, not by the erosion of water, but by a disruption of the rocks on either side, consequent upon the elevation of the range at these three several points.

If this theory be adopted, we are precluded, of course, in this instance, from appealing to the great depth of the valley, at the bottom of which the Baths stand, as indicative of the time required for eating so deeply into the substance of the volcanic rocks which bound it; but other proofs of great antiquity are not wanting, such as the existence of conglomerates consisting of rolled pebbles, which underlie one volcanic bed and which support another, as well as of tuffs containing fragments of the trachyte and basalt of the neighbourhood.

In some places, also, as in the Department of Cantal, fragments of limestone containing impressions of plants are scattered through these trachytic conglomerates.

And it would be a bold thing to maintain that, whatever may have been the case with the particular valley alluded to, none of the others which score the sides of the volcanic tableland have been due to the action of water, or even that such as have been originally produced by upheavement were not subsequently modified by denuding agents.

In short, the same arguments which induce geologists to assign a very long duration to those operations of nature which have in other countries scooped out the valleys and moulded into its present form the earth's surface, apply equally to the case of that more ancient volcanic region in Central France which has been just alluded to.

Everything therefore concurs to bespeak a high antiquity for these formations, and to indicate a long-continued operation of denuding forces upon the beds of igneous matter since their eruption; and yet all these events must have been posterior to the formation of some at least of the fresh-water beds of the Auvergne country, formations which Sir Charles Lyell refers to the Eocene period, still a portion of the Tertiary or of the youngest Member of the great Family of rocks.

It seems indeed most probable, that these eruptions of igneous matter had broken out at the time when the district was covered by extensive sheets of fresh water, like the great lakes of North America, and hence may have been derived their greater compactness, as compared with the more modern volcanic products before alluded to, an indication of their having been erupted under a pressure greater than that of the atmosphere. And yet, when we recollect that in the Eocene period about $3\frac{1}{2}$ per cent. of existing species of molluscæ were already in being, whereas in the newest of the subjacent secondary rocks no one living form has been as yet detected, and when we consider, moreover, how many distinct races of animals and of plants, all of which have passed away, succeeded each other in periods antecedent to the first dawn of the Tertiary epoch, it must be admitted, that vast as was the time occupied in bringing about the long series of igneous formations which we witness in Auvergne, it sinks almost into insignificance by the side of that period of incalculable duration which must have elapsed since the globe became first fitted for the maintenance of organic life.

And this leads me to another point of some general interest—namely, that volcanic action, notwithstanding its long continuance in one district, shifts its ground from time to time, so as probably in the course of years to visit in succession every region of the globe.

Before the close of the Eocene period, when the volcanos of Auvergne first came into activity, those of the Hebrides, of the North of Ireland, and of parts of Scotland had become extinct, and yet we have reason to believe that these last were for the most part contemporaneous with the chalk, and do not date back so far as the Oolite.

That they are entirely *burnt out,* may be inferred from the absence, throughout the whole space comprised within their several areas, of thermal springs, and of the severer forms at least of earthquake, which cannot be said of Auvergne; for the latter volcanos, though, as I believe, not in activity since the earliest periods of history, still give evidence of smouldering internal fire in their warm springs, evolutions of carbonic acid gas, and in occasionally recurring earthquakes of considerable intensity.

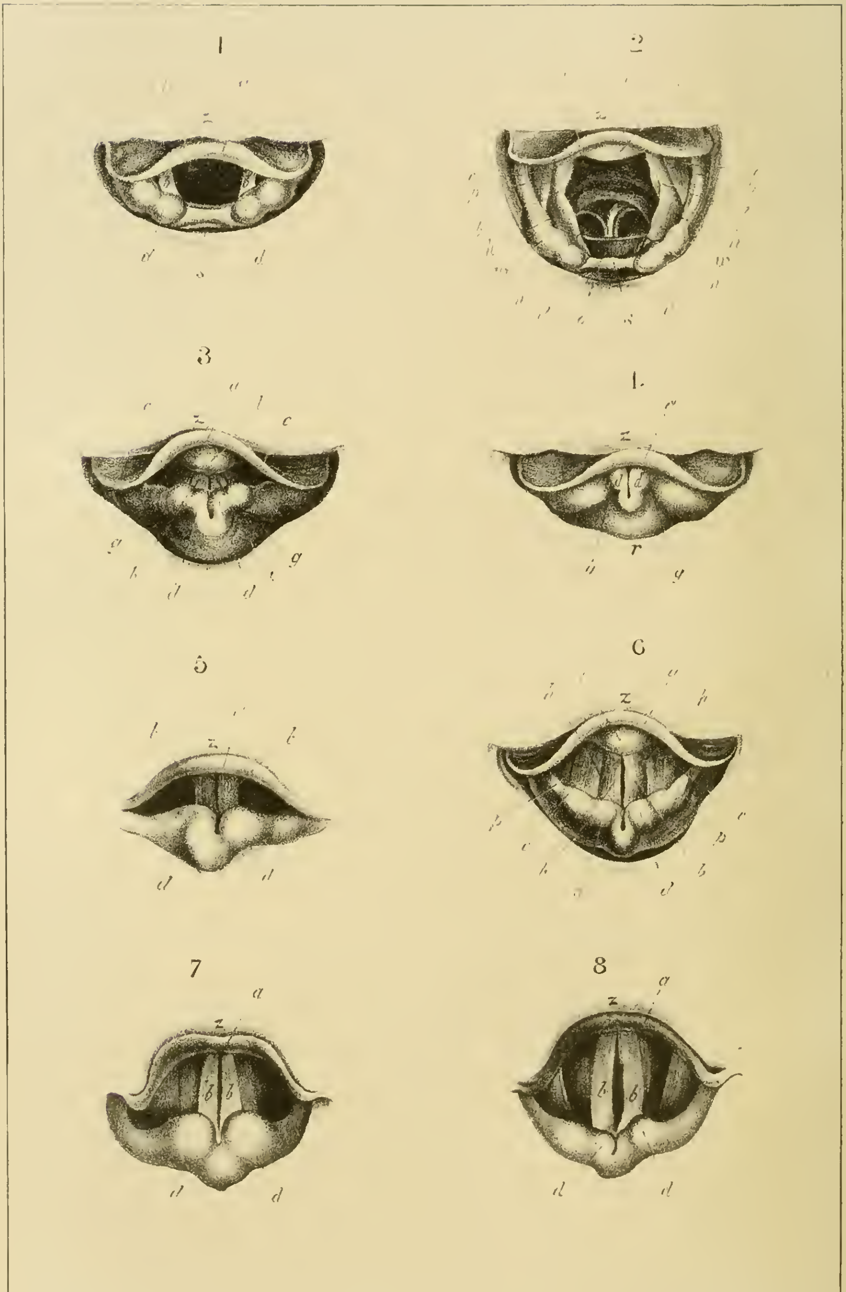
It would be easy to point out volcanic regions of still greater antiquity in other parts of the globe, which became extinct even before the igneous operations in the Hebrides, &c., had commenced; but it may be most to the purpose to note that in the highly vulcanized region of Southern Italy, the Apennine limestone, there so abundant, and of an age corresponding to the Jura or Oolite, exhibits no proof of igneous action having extended back so far as the period at which their beds were deposited.

From these considerations it may be inferred, that every portion of the globe is destined at one time or another to become the theatre of similar catastrophes.

Perhaps in some future time a chain of burning mountains may show itself along the coasts of Scandinavia; perhaps Australia may hereafter experience some of those underground convulsions which are now so rife amongst the islands of the Pacific.

And if so, what an impression is conveyed to the mind as to the length of time which must have elapsed since the planet we inhabit was first called into existence, or, indeed, even as to the number of years which have rolled on since the commencement of organic life.

For from the period occupied by one only of these epochs, that which has been pointed out in Auvergne, we may form some slight estimate of the remainder, and the aggregate certainly presents an idea of past time which it is difficult for our limited faculties fully to realize.



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THE HUMAN LARYNX.

A few of the many Physiological changes observable by means of the Laryngeal Mirror

V. ON THE LARYNGOSCOPE, AND SOME OF ITS PHYSIOLOGICAL REVELATIONS.

By Cornelius B. Fox, M.D. Edin., M.R.C.P. Lond.

(*Illustrated.*)

The Laryngoscope is, as its name implies, an instrument for the examination of the larynx or vocal apparatus, whereby we can not only study with facility the normal action of its various parts in the production of sound, but by which the abnormal and diseased conditions of this organ may be, in general, diagnosed with certainty. The Rhinoscope, for the inspection of the posterior part of the nasal cavities, and the Autolaryngoscope, for the examination of one's own larynx, are merely modifications of the Laryngoscope: a description of these instruments, however, does not fall within the compass of this paper.

1. *The History of the Laryngoscope.*—In 1743, a distinguished Frenchman, named Levret, employed himself in ascertaining the manner in which polypi of the nostrils, throat, ears, and other parts could be removed by ligatures. An illumination of these regions was produced by the aid of a polished plate of metal, on which light was projected and in which the illuminated parts were seen.

In 1807, a pamphlet was published at Weimar, by Dr. Bozzini, of Frankfort-on-the-Maine, on 'The Light Conductor, or a Description of a simple Apparatus for the illumination of the Internal Cavities and Spaces in the Living Animal Body.' This instrument essentially consisted of a number of hollow metal tubes, of various diameters, adapted to the different canals of the body, and of a lantern, to which they all could be fitted. Finding it necessary to employ reflected light in the examination of the larynx and posterior part of the nasal cavities, he had a speculum—at one end of which was a mirror—divided by a partition into two parts: one canal and half of the mirror serving to transmit the light and the other the image. Although he was evidently well aware of the means required for the examination of the larynx, yet his observations in this region seem to have been confined to the posterior part of the nasal cavities. In 1827, Dr. Senn, of Geneva, attempted to obtain a sight of the larynx of a child who was labouring under great difficulty of breathing by means of a small mirror, but was unsuccessful in his endeavours, because he did not illuminate the parts.*

In March, 1829, Dr. B. G. Babington exhibited to the Hunterian Society an oblong piece of looking-glass attached to a portion of silver wire, which he called a Glottiscope. By placing this instru-

* *Vide* 'Journal de Progrès,' 1829.

ment against the palate, and reflecting thereon the sunlight with a common back-hair glass, he saw the epiglottis and upper part of the larynx. He subsequently attached to the mirror a tongue-depressor, but after a time abandoned this addition, and substituted polished steel for the glass mirrors.* In 1830, Gerdy wrote, "La contraction du pharynx se vérifie aisément à l'œil au moyen du miroir."† In the year 1832, Dr. Bennati, of Paris, announced to the world the possibility of seeing the vocal chords by means of an instrument, in all probability exactly similar to, if not identical with, that of Selligue, to be immediately described.‡ Trousseau and Belloc, in their 'Memoire sur la Phthisie Laryngée,' published in 1837, refer to an instrument made by an ingenious mechanic, named Selligue, who was affected with that disease. It closely resembled that of Bozzini, consisting of "a double-tubed speculum, of which one tube served to convey the light to the glottis, and the other to bring back to the eye the image of the glottis, reflected in the mirror placed at the guttural extremity of the instrument.

These authors state that it was very difficult of application, and that not one in ten could bear its introduction. In 1838, Monsieur Beaumês, of Lyons, exhibited before the Medical Society of that city a mirror for the examination of the throat, larynx, and posterior part of the nasal cavities.§ The distinguished surgeon Liston speaks of obtaining a view of an "ulcerated glòttis by means of a small mirror, similar to that employed by dentists, on a long stalk, and dipped in hot water before its introduction into the throat." ‖ In 1844, Dr. Adam Warden, of Edinburgh, read a paper before the Royal Scottish Society of Arts on 'The Employment of a totally reflecting Prism for illuminating the open Cavities of the Body.'

Having been very successful in his examinations of the auditory canal, he directed his attention to the larynx, which he made visible by the employment of an additional prism placed in the throat, and associated with an instrument for depressing the tongue and expanding the faucial cavity. He referred to two cases, in which he had obtained "satisfactory ocular inspection of diseases affecting the glottis," but evidently did not consider this mode of examination as one which promised much success.

From 1846 to 1848, Mr. Avery, of London, employed instruments for inspecting the throat, posterior part of the nasal cavities, and other regions. His Laryngoscope was a cumbrous piece of apparatus, worn on the head and nearly a pound in weight. It consisted—1° of a circular reflector, perforated in the centre, for

* *Vide* 'Lond. Med. Gazette,' March 28, 1829.

† 'Physiologie Médicale,' p. 503.

‡ *Vide* 'Recherches sur le Mécanisme de la Voix Humaine.'

§ *Vide* 'Compte Rendu des Travaux de la Société de Médecine de Lyons,' 1836-38.

‖ 'Practical Surgery,' 3rd edit., p. 417, published in 1840.

the concentration of the rays of light emanating from a candle fixed in front of it; and 2°, of a speculum attached to the opposite side of the candle, and containing at its extremity a laryngeal mirror. He seems, however, subsequently to have forsaken the speculum, and employed solely small laryngeal mirrors, "made of solid lumps of metal." He affirmed, that with his Laryngoscope he had occasionally been able to see the bifurcation of the windpipe. In the year 1850, the medal of the Society of Arts was awarded to him for his labours. Monsieur Desormeaux, of the Hôpital Necker, in Paris, has employed for many years past an instrument which resembles Bozzini's, for the examination of the urethra, posterior part of the nasal cavities, the throat, as well as other parts.* Monsieur Garcia, the eminent professor of music, was the first experimenter who succeeded in obtaining a sight of his own larynx. The method he employed was the following:—Placing himself with his back to the sun, he introduced into his throat a little mirror, attached to a long stem; on this he cast the rays of light by means of a looking-glass. and in this same glass he saw the reflection of his larynx. This mode of examination was precisely that of Dr. Babington, who, however, made no attempt at autolaryngoscopy. After having studied the mechanism of the human voice during singing, he presented a paper to the Royal Society of London, in 1855, entitled, "Physiological Observations on the Human Voice."†

This paper, meeting the eye of Dr. Türck, of Vienna, that gentleman was induced to employ the laryngeal mirror in the wards of the General Hospital in 1857, but apparently without the as istance of any illuminating mirror whatever. In November of that year, Dr. Türck, having ceased to employ his mirrors, lent them to Professor Czermak, of Pesth, who made the very important addition of a large circular mirror for the concentration of the light. This mirror was perforated in the centre, and so arranged as to bring the perforation in front of the pupil of the examiner's eye. Although many of Czermak's predecessors were acquainted with the principles, none of them completed the art. To him, then, who is named by Dr. Gibb the father of Laryngoscopy, is due the credit of having perfected the Laryngoscope and introduced it to the scientific world.

Czermak's first essay on the subject appeared in 1858, and was named 'Physiological Researches with the Laryngeal Mirror of Garcia.' This was followed by various papers, the most complete and comprehensive of which was published by the New Sydenham Society in 1861, and entitled, 'The Laryngoscope and its Application to Physiology and Medicine.'

Finally, the names of Battaille, Merkel, Semeleder, Stoerk,

* *Vide* 'De l'Endoscope et de ses Applications,' 1865. Paris.
† 'Proceedings of the Royal Society of London,' vol. vii., No. 13. 1855.

Gibb, and Mandl should not be omitted whilst referring to labourers in this field.

2. *The Instrument.*—The most essential part of the Laryngoscope is the laryngeal mirror. It should be made of silvered plate-glass, and set at an angle of 120° with its stem. It may be circular, or square with the angles rounded, and if from $\frac{6}{10}$—$\frac{8}{10}$ of an inch in diameter, will be found most generally useful. The illuminating silvered glass mirror ranks next in importance; it should be slightly concave, perforated in the centre, of about 3½ inches in diameter, and possessing a focal power of 14 inches. It is desirable to have the mirror attached to the frontal pad or spectacle-frame, by means of a ball and socket-joint, and so arranged as to be worn at pleasure, either in front of the eye or on the forehead. As to the light, nothing equals the solar rays; but as they are not always to be obtained, it is necessary to resort to artificial illuminating sources. The bright, steady flame of a good German lamp —especially if a Tobold's condenser is adapted to it—leaves little to be desired. A tongue-depressor is often requisite: one composed of vulcanite, with its under-surface serrated, so that some traction may be exerted on the tongue, is found by the writer preferable to any other form.

3. *Mode of employing the Laryngoscope.*—The individual to be examined should be seated upright in a chair, with the head slightly inclined backwards, the mouth widely opened, and the tongue protruded. If the solar rays are available, his back should be turned towards the sun, but if artificial light is necessary, the lamp should be placed on a table by his side, and at such an elevation as to be on a level with the ear. The observer, being seated immediately in front of the observed, and having his illuminating mirror on his forehead, or in front of either eye (in which latter case he gazes in the direct axis of the illuminating rays), should hold the protruded tongue firmly between the fore-finger and thumb of the left hand, previously enveloped in a cloth or handkerchief. The rays proceeding from the illuminating source are easily directed by a little adjustment of the mirror into the throat, having not only undergone reflexion, but concentration. The laryngeal mirror, being held like a pen in the right hand, is to be heated over the lamp, to prevent the condensation on it of moisture. Before its introduction, the temperature of the mirror should always be tested by placing it on the back of the hand or on the cheek, to prevent the possibility of burning the throat. Having been carefully passed over the base of the tongue, so as to avoid contact with that organ, it should be made to rest on and slightly raise the uvula—that is, if we wish to look vertically down the laryngeal tube. The base of that unruly member, the tongue, has very often a great tendency to rise towards the palate, thus obstructing both light and vision.

When in such a case an ordinary tongue-depressor is employed, it sometimes happens that the *extreme* base of this organ, which cannot be touched by the instrument on account of the retching excited, is unavoidably pressed backwards, and the glottis is thus closed by its lid, the epiglottis. An instrument which will not only depress, but one which will at the same time exert some slight traction on the tongue, such as has been already briefly referred to, is found very frequently serviceable.

A knowledge of the structure of the various parts of the larynx is, of course, indispensable to those who would study their functions, for one can then more readily understand the different appearances observable in the laryngeal mirror.

The condition of the larynx in a quiescent state during ordinary tranquil respiration is represented in Fig. 1. The glottis is seen to be freely opened, and one observes a large portion of the anterior wall of the windpipe. When the person experimented on takes a deep inspiration, we see the arytenoid cartilages and vocal cords widely separated, the cartilaginous rings of the windpipe, &c.; and, if the neck is straightened, we may, in favourable circumstances, obtain a view of the bifurcation of this tube,—*vide* Fig. 2. On making a succession of expiratory efforts, as in laughing, in which case the syllable "ha" is rapidly repeated, the arytenoid cartilages and edges of the vocal cords are suddenly brought into juxtaposition and then separated with equal agility during each intermission.

The action of the larynx during the process of deglutition is interesting, but somewhat difficult to observe. It undergoes a complete closure, so as to prevent the entrance of any alimentary matter.* The changes seen are thus given by Czermak:—1. An intimate apposition of the arytenoid cartilages, and of the true and false vocal cords occurs. 2. The false vocal cords also approach the true cords, so as to obliterate the ventricles of Morgagni. 3. The epiglottis is lowered, its cushion at the same time becoming more and more prominent, until it reaches the fold of mucous membrane which encloses the arytenoid cartilages. Figure 3 represents the commencement of the closure, as seen in the laryngeal mirror. When the larynx is completely closed, we see an image analogous to that of Figure 4, with this difference, however, that in the latter there exists a free space for the passage of air between the epiglottis and the arytenoid cartilages, whilst in the former this space is occupied by the cushion of the epiglottis, and the closure is *hermetic*.

The voice is formed, according to Garcia, "by the compressions

* The conclusions deduced from the experiments of Mons. Guinier, recently brought before the Academy of Sciences of Paris, have been questioned. The view that the food comes into contact with the vocal cords in deglutition was ably refuted by Dr. Gibb at the last annual meeting of the British Association for the Advancement of Science.

and expansions of the air, or the successive and regular explosions which it produces in passing through the glottis." It may be inspiratory or expiratory; the latter, however, will be alone referred to in the following observations. The inferior or true vocal cords *alone* give origin to sounds, the superior or false cords taking no part in the generation of these sounds, whatever their register or intensity may be. When we desire to produce a sound, the arytenoid cartilages approach one another with an astonishing mobility and freedom of action. The vocal cords, thus becoming approximated, assume what is termed "the vocalizing position." In the production of the lower notes, the vocal cords are seen to vibrate throughout their entire length, and, probably, throughout their entire breadth also. As the voice ascends from its lowest to its more acute notes, the lengths of the vibrating portions of the vocal cords are proportionally diminished, their tensions are increased, and the arytenoid cartilages become more closely apposed.

The vocal cords, in fact, present the same phenomena as those of musical cords, and appear to obey the same laws.* It is almost impossible to study the condition of the larynx during the production of the lowest chest sounds, because the arytenoid cartilages, becoming elevated, rapidly approach one another, even to complete contact, and bend themselves under the border of the depressed epiglottis, so that this latter entirely conceals from vision the interior of the larynx,—*vide* Fig. 4. There is, in all probability, however, no considerable difference in the behaviour of the larynx during the emission of the gravest sounds and those less grave. The appearance of the glottis when Do[1] of the chest register is sounded has been represented in Fig. 5. The state of the interior of the larynx during the emission of the most acute sounds is, on the other hand, very readily observed. The glottis is contracted into a linear form, and the various parts of the larynx are felt to be in a state of great tension,—*vide* Fig. 6. Three registers of the expiratory voice are generally described: the chest register, which commences lower in a man's voice than in a woman's; the falsetto register, extending equally in both voices; and the head register, which reaches higher in the female voice.

Table of the Human Voice in its full Extent.

Garcia has observed, that during the production of the chest

* *Vide* 'Observations on the Movements of the Larynx when viewed by means of the Laryngoscope,' by J. Bishop, F.R.S., in 'Proceedings of the Royal Society London,' June 5, 1862. Vol. xii.

tones a larger surface of the vocal chords is in a state of vibration than when the falsetto notes are emitted, in which latter case the extreme edge only of the vocal cord vibrates, and a much less expenditure of breath is required.

Great difference of opinion prevails as to the exact mode in which the falsetto notes are produced. Amongst those who have especially studied this subject, the names of Magendie, Mayo, Müller,* and Lehfeldt, Willis, Pétrequin, and Diday, Bishop, Battaille, and Wheatstone may be mentioned.

These registers may be compared with greater facility if thus represented :—

Chest Register.	Falsetto Register.
1. The vocal chords vibrate *throughout their whole extent*, viz., in their subglottic and ventricular regions and on their free border.	1. The vocal cords vibrate only on their free border, and in their ventricular region, *the subglottic region ceasing to take any part* in the generation of sound.
2. Vibrations become *more* rapid and *ample* as the sound becomes more acute; the reverse occurring when the sound becomes more grave.	2. Vibrations become *less ample* and more rapid as the sound becomes more acute: but when more grave, the reverse takes place.
3. Longitudinal tension is *stronger* than in the falsetto register.	3. Longitudinal tension is *feebler* than in chest register.
4. Opening of the glottis is *rectilinear*.	4. Opening of the glottis is more or less *elliptic*.†

If Mi$\flat^3$ of the chest register be produced, and then, without any interruption to the current of air emitted, the experimenter suddenly passes to the same note in the falsetto register, the difference in the appearances reflected in the laryngeal mirror will be found to be very striking,—*vide* Figs. 7 and 8. The existence of a third register has been denied by Müller, Bennati, and Gibb. Garcia very briefly refers to the head register and its relation to the falsetto, laryngoscopically, in his paper already referred to, which is also contained in the under-mentioned pamphlet.‡ Lastly, Battaille writes of the head voice in the following manner :— "L'anatomie et la physiologie repoussent également la dénomination de voix de tête, fort improprement appliquée au registre de fausset." The interesting revelations above disclosed to us by the aid of the laryngoscope alone afford proof of the great value of this instrument, not only to the physiologist, but also to the vocalist. Its great assistance, moreover, to the physician cannot be overestimated; for it is only by the multiplication of such instruments as the ophthalmoscope, the laryngoscope, &c., whereby diseases can be seen by the eye and determined with certainty, that the science of medicine can surely, although perhaps slowly, proceed to that

* The experiments of Professor J. Müller, of Berlin, relative to the production of vocal sounds are extremely interesting. *Vide* 'Ueber Compensation der Phys. Kräfte am Menschlich. Organ.' Berlin, 1839.

† *Vide* 'Nouvelles Recherches sur la Phonation,' par Ch. Battaille. Paris, 1861.

‡ 'Notice sur l'Invention du Laryngoscope,' par Paulin Richard. Paris, 1861.

advanced stage towards the ultimate goal of perfection which is already reached by many of the other sciences.

EXPLANATION OF THE FIGURES.

The anterior portion of the Larynx is represented above, and the posterior part below:—

Fig. 1. Represents the appearance of the larynx during tranquil respiration. The epiglottis is raised, the glottis is widely opened, and a portion of the anterior wall of the windpipe is visible.

Fig. 2. The condition of the larynx during a deep inspiration. The rings of the windpipe, and its bifurcation into the two bronchial tubes, are here apparent.

Fig. 3. Represents the semiclosure of the glottis during the act of swallowing.

Fig. 4. The appearance of the glottis during the production of the gravest chest sounds (after Czermak).

Fig. 5. The appearance on the emission of the chest sound Do[1] (after Battaille).

Fig. 6. The condition of the larynx during the production of the most acute sounds.

Fig. 7. The appearance of the glottis on emitting Mi♭[3] of the chest register.

Fig. 8. The appearance on suddenly passing to Mi♭[3] of the falsetto register (Battaille).

a. The epiglottis.
b. The inferior or true vocal cords.
c. The superior or false vocal cords.
d. The tubercle of the cartilage of Santorini, which rests on the apex of the arytenoid cartilage.
g. The arytenoid cartilages.
h. The ventricles of Morgagni.
l. The anterior wall of the windpipe.
m. Right bronchus.
n. Left bronchus.
o. The posterior wall of the larynx.
p. The aryteno-epiglottic ligament.
r. The posterior wall of the gullet.
s. The entrance of the gullet, the line of demarcation between the wall of the pharynx and the posterior surface of the larynx.
t. The cushion of the epiglottis.
w. The tubercle corresponding to the cartilage of Wrisberg.
z. The base of the tongue.

VI. COMPARATIVE PHILOLOGY AS INDICATING THE ANTIQUITY OF MAN.

By David Parkes, President of the Sheffield Literary and Philosophical Society.

Writers on the Antiquity of Man generally attempt to demonstrate their position by referring to the undoubted remains left by man during ages long past, such as the lake dwellings of Switzerland and other places, rude pottery found in Egypt in the Nile deposits, which have been formed during years to be numbered by tens of thousands, flint implements discovered in the gravel pits of Abbeville, the contents of immense shell mounds, and other débris found in Denmark, the Neanderthal skull, &c., to all of which an almost incalculable antiquity has been assigned. Such investigations are now open to every one, and the mere reading of Sir Charles Lyell's work on 'The Antiquity of Man,' would be sufficient to convey a general and, in fact, very good idea of the subject. The question has, however, been discussed from these data almost to exhaustion, and on this account I shall form no theory nor draw any conclusions from such data, but proceed by a more original and perhaps equally conclusive mode of reasoning, *viz.* the application of Comparative Philology to this most important subject. This has never been done in detail, though many able writers, such as Sir Chales Lyell and the author of 'Vestiges of the Natural History of Creation,' have illustrated the subject in general terms, but have not entered into those minute details which alone are able to carry conviction to scientific minds. Although the investigation must be attended with difficulties, and the examination of mere words may be uninteresting to many, the subject shall be treated as agreeably as the nature of it will allow, and at the same time as fully as the brief space allotted to such a subject in a journal will admit of.

The comparison of languages is now very generally admitted to be a much more certain method of determining the place of man in Creation than the mere peculiarities of colour and bodily conformation, or any other external circumstances, inasmuch as language is the very embodiment of thought, or the expression of all mental conceptions, and therefore altogether psychological. The author of the 'Vestiges,' the last edition of whose work was published in 1860, says:—"Language is a profound expression of the idiosyncrasy of a people, not easy to be obliterated or disguised. There are upon earth between three and four thousand languages, perhaps for the most part as distinct from each other as French, English, German, but like these exhibiting relationships which at once enable us to decide on the relationships of the nations to which they belong. A relationship amongst languages is shown in the community of words or roots of words. This is the kind of relationship with which we are most familiar; but it is one liable to some obscurity, as it may either happen that all or nearly all traces of a common vocabulary have perished between nations known to be akin, or there may be a community of words that is only the result of accident. By far the most certain test of an affinity between languages is the trace of a common character or analogy in their grammatical structure and in their laws of combination—what has been well called the mechanism of speech. This is both a more immediate and distinct expression of intellect, and one which tends to be more permanent."

The languages of most civilized nations are intimately connected with each other, so as in fact to show *one* centre of creation, although the author just quoted says, that the *six plans* of languages into which he divides the tongues of the whole human race appear to have originated in entire independence of one another, and are each expressive of the idiosyncrasy of a *distinct* family of mankind. I hope I shall be able in the course of my present investigation fairly to controvert this bold assertion, supported as it is by Renan ('Histoire Générale des Langues Sémitiques') and many other authors of the same school. A later and much better classification is that adopted by Professor Max Müller, who divides all the languages of mankind into three great families—the Aryan, Semitic, and Turanian. The Aryan or Indo-European comprises the Sanskrit and its modern derivatives, also Persian, Greek, Latin, and all the Keltic, Teutonic, and Slavonic languages of ancient and modern Europe. The Semitic family consists of Hebrew, Arabic, Eastern and Western Aramean, commonly called Chaldee and Syriac, and some other languages and dialects which were anciently spoken in Palestine, Phœnicia, Babylonia, Mesopotamia, and Arabia. The Turanian comprises the Chinese and all other languages which still as in past ages remain extensively agglutinative. Max Müller thinks the Aryan and Semitic are the only families of speech deserving to be so called, and a very few of the languages of these two families will, at this time, exclusively engage our attention.

It is a very interesting circumstance that many important facts may be ascertained relative to the state and civilization of man even in pre-historic times, from the existence of certain words in any family of languages. One great fact is, that before the first separation of the Aryan family of mankind which had most probably its original dwelling-place "as far east as the western slopes of the Belurtag and Mustag, near the sources of the Oxus and Yaxartes, the highest elevation of Central Asia," and long before the dawnings of history, civilization had made rapid strides. On this subject Professor Max Müller, who, although a foreigner, expresses himself with all the force, perspicuity, and felicity of style of the very best English authors, says, "It can be proved by the evidence of language that before their separation the Aryans led the life of agricultural nomads, a life such as Tacitus describes that of the ancient Germans. They knew the arts of ploughing, of making roads, of building ships, of weaving and sewing, and of erecting houses: they had counted at least as far as one hundred. They had domesticated the most important animals - the cow, the horse, the sheep, the dog; they were acquainted with the most useful metals, and had recognized the bonds of blood and the bonds of marriage; they followed their leaders and kings, and the distinction between right and wrong was fixed by laws and customs. They were impressed with the idea of a Divine Being, and they invoked it by various names. All this, as I said, can be proved by the evidence of language. We could not find, for instance, the same name for house in Sanskrit, Greek, Latin, Slavonic, and Celtic, unless houses had been known before the separation of these dialects. In this manner a history of Aryan civilization has been written from the archives of language stretching back to times far beyond the reach of any documentary history."*

The Semitic languages were spoken from the eastern shores of the Mediterranean to the River Tigris, and even beyond that boundary eastward, and from the Caucasian mountains on the north to the Arabian peninsula, extending to the Indian Ocean on the south. Similar interesting circumstances may be predicated of this grand division of the human race to those which Professor Max Müller has elicited respecting the Aryans. Thus, the term for gold is the same in Hebrew, Arabic, Chaldee, and Syriac, and so is that for brass or rather copper. This shows that while the various tribes of the Semitic family were inhabiting the same locality, those metals were known to all; for had the various tribes already separated, all could not possibly have given the same names to those metals. Not so, however, with respect to iron, because the word for iron (*barzel*) is the same in Hebrew, Syriac, and Chaldee, but not in Arabic. Therefore the Arab branch of the family must have separated first from their fellow Semites, and retired to the Arabian peninsula before the discovery of iron. This event evidently occurred during the age of bronze, which had succeeded that of gold, and before the age of iron commenced; the discovery of iron was, however, made by the Semitic race in pre-historic times. During the age of bronze and before the final separation of the various tribes, the Semites, like the Aryans, were agricultural nomads, the words for plough and ploughing being the same in the speech of all, and they not only dwelt in tents, but possessed houses, and had already formed villages and cities many thousands of years before the commencement of the Christian era, and at the latest during the age of bronze. It is impossible to determine when iron became known to the Arab tribes, but the Chaldeans and Hebrew-speaking nations certainly knew it long before them.

The Semitic tongues, though now and for so many ages differing so widely from the Aryan, can be clearly shown to have originated in one common source with them. Many, and in fact most, objects are designated by different words in each of these two great families of languages—thus river in Hebrew is *nahar*, and in Latin *flumen*. These words are widely dissimilar both in sound and appearance; but when we know that the Hebrew *nahar* is derived from the root *nahar*, *to flow*, and that the Latin is from *fluo*, also *to flow*; that the Spanish *Rio* and the French and Italian equivalents find their root in the Latin *ruo*, Greek *rheo*, to flow; and that this instance is only one of very many, we see that the same idealism

* 'Lectures on the Science of Language.' First Series, p. 245.

and the same mode of reasoning characterized the original speakers of both the Aryan and Semitic languages, and we can draw the inference quite logically that these races of men were, at least, of the same species, though we could not assert, on such principles only, that they had a unity of origin. So in the case of silver. Silver is *keseph* in Hebrew, from *kasaph*, to become pale or white. So, in Sanskrit, silver is counted as white, and called *sveta*. Thus, also, Hebrew *zahav*, *gold*, from *tsahav*, to shine, *tsahov* meaning yellow, as gold in German is so termed, doubtlessly from its yellow colour. *But* if we can show a *community* of words and grammatical forms, or a sufficient number of them, we may justly conclude that the Aryans and Semites were not only of the same species, but of one family, contrary to the hypothesis of those who, like the author of the 'Vestiges of the Natural History of Creation,' maintain various centres of creation and an entire distinction of race amongst the several families constituting the genus *Homo*.

Now it has been estimated that if only *eight* words were found to be identical in two languages, it would be, according to the doctrine of chances, nearly 100,000 to 1 that they were derived in both cases from some parent language, and that, of course, eight such words would furnish evidence of a common origin scarcely short of absolute certainty; but without stringently insisting on this, which is, however, an ingenious calculation, such a multitude of words exist in the Aryan and Semitic languages common to both families, that it becomes impossible to draw any other conclusion than that all those languages, widely as they are now diffused, and much as they differ from each other, originated during the infancy of the human race in one locality. In order to account for the origin of language, Renan supposes all the roots of words to be onomatopoetic; but others, and chiefly Prof. Max Müller, assert that onomatopoeia has furnished only few words in the Aryan languages. In the Semitic tongues, certainly, many words and roots are onomatopoetic, but, in proportion to the whole number of words in that family, they are comparatively few. It appears highly probable that the first words uttered by man were onomatopoetic, and that man who, from the first moment when he became conscious of being, possessed the power to think and organs of speech, affected by the sounds which he heard and by the sight of all the natural objects around him, would at once imitate those sounds by an almost involuntary exertion of his vocal organs, and contemplate those objects with an eye of curiosity and wonder, not devoid of intelligence. His reflective faculties would soon be brought into operation, and he would naturally give vent to his feelings in words which, once uttered, became the representatives of things from that moment through all succeeding time. This seems to be the most reasonable mode of accounting for the origin of language; but, although volumes might be written on that subject, as it is not the immediate question under discussion, we must again proceed to discuss the phenomena of words; but, as by comparing those which appear to be the same in both Indo-European and Semitic languages, it is our primary object to prove a unity of origin, words clearly onomatopoetic, however numerous, will be scrupulously avoided. Now, in illustration let us commence with the Hebrew roots, *oon* and *een*, which signify negation. This is expressed in many languages by the letter N. So, in Sanskrit, *na, no, an;* Persian, *nah, na;* Zend and Coptic, *an;* Greek, *nē;* Latin, *ne, nemo, non;* German, *nei, nein;* and English, *no*. The Hebrew word *īsh*, man, is certainly primitive, and in Sanskrit is found *isha*, master, and *ishi*, mistress, answering to Hebrew *ishsha*, woman. So *īsh* is often used in the Old Testament Scriptures in order to distinguish a man of influence from *adam*, a common man. Hebrew *aim*, mother, is also a primitive word and, perhaps, onomatopoetic; it appears in the Greek, *mamma, mammē*; Coptic, *man;* German, *mama, amme;* English, *mamma;* and in Arabic the root *amma*, to be a mother, occurs. It is remarkable that the word mother, as Prof. Max Müller observes, "has not only the same root in Sanskrit, Greek, Latin, German, Slavonic, and Celtic, namely, the root *mâ*," this being equivalent to the Arabic *am*, "but likewise the same derivative *tar*, so that there can be no doubt that in the English *mother* we are handling the same word which, in ages commonly called *pre-historic*, but in reality as historical as the days of Homer or the more distant times of the Vedic Rishis, was framed to express the original conception of genetrix;" and I wish to call attention to the fact that, not only in ages so remote, but even from the time when man became a speaking animal, the same root was used and in the same signification.

My object here is to compare such a great number of words common alike to the Indo-European and the Semitic families, as to leave no doubt on the mind of every student of language that, originally, both families were united, or rather sprung from the same origin. Thus, in Hebrew, Chaldee, and Syriac, *ānak* signifies to strangle and to be in anguish; and in Greek we find *ancho* and *ananchē;* in Latin, *angere* and *angustus;* in German, *enge, angst;* and in Sanskrit, *anhus*. Hebrew, *ārag*, to weave, is used of the spider, in Greek called *arachnē*, *rag*, the primary syllable of the root, having the power of rapid motion and agitation. Hence to be moved hither and thither; and so we find Sanskrit *rag*, to move; Latin, *regere;* and German, *regen*. The Hebrew root *parah*, to bear, is found in many Indo-European languages, as in Sanskrit, *bhri*, to bear; Persian, *bār*, a burden; Armenian, *bieril;* Greek, *pherō;* Latin, *fero* and *porto;* Gothic, *bairan;* English, *to bear;* and old German, *bären*. From the Hebrew root *ānah*, to groan, is derived the noun *anēha,* sorrow, identical with the Greek *ania*, sorrow. Hebrew, *argāmān*, purple; in Sanskrit, *ragaman*, tinged with a red colour. The Hebrew word for earth is *eretz;* the Chaldee and Syriac, *ar'ah* and *ar'o;* Sanskrit, *dhara. Pelevi arta*, whence *terra;* Gothic, *airtha;* German, *Erde.* It must not be forgotten that, according to the recognized laws of language, letters of the same organ are frequently interchanged for each other, as *b*, *p* and *f*, for instance, as well as dentals for sibilants, &c., otherwise, the analogies of words will not be so easily recognized. Thus, in Hebrew, *bārad* means *to scatter*, as *bārād*, hail, and as an adjective it means sprinkled with spots. Syriac, *barduno*, a leopard; Greek, *pardos;* and Latin, *pardus.* Before I proceed farther, I may say that I shall adduce no words in illustration but those found in the oldest Hebrew writings, which I am enabled to do by consulting Fuerst's admirable Hebrew Concordance and the Lexicon of Gesenius, one of the ablest Semitic scholars the world ever saw, and whose works will never cease to be of authority in Hebrew criticism. To proceed, Hebrew, *bāar*, like the Arab. *bār*, means to dig; and in Latin is found *forare;* and in English, *to bore.* Hebrew, *bar*, corn; Arabic, *bor*, wheat; Latin, *far*. whence *farina.* Hebrew, *pārāh*, to be fruitful, and *porah*, fruitful; Persian, *bar*, fruit. Compare also German *frucht* and English *fruit.* Hebrew, *shen*, a tooth; Arabic, *sinn.* With these agree the Sanskrit *danta;* Latin, *dens;* and Gothic, *tunthus;* Fris. *tan.* The Arabic *jins*, genus, has its equivalent in Greek *genos*; Sanskrit. *jati*, from *jan*, to be born; Gothic, *kuni;* Latin, *genus;* Hebrew, *dootz*, contracted from *dantz*, to dance or leap; German, *tanz;* English, *dance.* Again, Hebrew, *dōr* and Arabic, *dār*, to go round and in a circle, also to remain, delay, may be compared with Greek *dēros;* Latin, *durus, durare;* and German, *dauern.* Hebrew, *dāchak*, to repel, drive away, finds its equivalent in the Greek *diōkō.* Hebrew and Arabic, *hamar*, to flow in a rapid stream, agreeing with Greek, *ombros*; Latin, *imber.* Hebrew, *zā'am* (Arabic, *ja'am*, to foam at the mouth as a camel), to speak angrily, and as a noun, foam; German, *schaum, schaumen;* English, *scum*, and *to skim.* Hebrew, *yāda'*, like the Greek *eidon, oida*, to see; hence to perceive, know. "This root," as Gesenius observes, "is very widely extended in the Indo-Germanic languages, in the signification both of seeing and knowing, as Sanskrit. *wid, budh;* Zend, *weedem;* Greek, *eidō, idō, oida, daeō;* Latin, *video;* Gothic, *vitan;* German, *weten, wissen;* and also in the Slavonic tongues."—*Lex. in loco.* Hebrew, *kad;* Sanskrit, *ghada;* Slavonic, *kad;* Latin, *cadus;* Greek, *kados*, a jar or vessel for wine or water. Hebrew, *kavah*, to burn; Greek, *kaiō*; Old Attic, *kaō*; Sanskrit. *cush*, Hebrew, *koor*, to dig, bore through, and Arabic, *kaur*, a digging in the earth; Sanskrit, *k'hur*, to cleave, dig, and, as a Hebrew noun, *macherah*, from piercing; Greek, *machaira*, a dirk or sword. Hebrew, *kalah*, to close, shut up; Greek, *kleiō, kleis;* Latin, *clavis.* Hebrew, *kālam*, to wound, and Arabic, *klam;* Sanskrit, *klam.* Hebrew, *kāna*, to bow the knee; Greek, *gonu;* Latin, *genu;* Sanskrit, *ganu;* Gothic, *keniu;* German and English, *knie, knee.* Hebrew, *lāat, loot*, to wrap round; Sanskrit, *lud;* Greek, *lathō;* Latin, *lateo.* The Hebrew *kol*, voice, from *kol*, to call, is extensively used; Sanskrit, *kal*, to sound; Greek, *kaleō;* English, *to call.* Hebrew, *madad*, to measure; Sanskrit, *ma, mad;* Zend, *meete, mate;* Greek, *metron, medimnos;* Latin, *metior, meta;* Gothic, *mitan;* Anglo-Saxon, *metan;* and German, *messen.* Hebrew, *mooth*, to die, appears in all the Semitic languages, and in many of the Indo-European. The middle radical seems to be softened from the liquid *r*, an example of which is found in Hebrew *darash* and *doosh*, so that the original stem would be *mrt;* Sanskrit, *mri*, to die, *mrita*, dead, death—also, *math, muth, mith, meth, mid, med*, to kill; Malay, *mita*; Zend, *mrete;* Pelev. *murdeh, mard, mortal, man;* Persian, *mardan*, to die; Greek, *mortos;* Latin, *mors, mortis;* German, *mord.* To these may be added the New Zealand, *i.e.* Maori, *mate*, to die, cognate, like many other words in the language of New Zealand, with the Malay, and perhaps Sanskrit.

Again, Heb. *mālā*, to fill, Arab. and Syr. idem. This root, like the last, seems to be co-existent with the origin of the two families of languages which we are comparing with each other—*m* being changed for *p* and *f*, in accordance with the law which frequently changes the letters of the same organ for each other, in this case all labials: thus—Sanskrit, *ple*, to fill; Gr. *pleō, plērēs, bluō, bruō;* Lat. *plere, plenus*; Goth. *fullyan;* Ger. *füllen voll;* Eng. *full, fill*, &c.; Heb. *māsach*, to mix. This root is also widely extended, appearing in Hebrew, Arabic, Chaldee, and Syriac, also in the German *mischmasch*; Sanskrit, *maksh* and *misr*; Gr. *misgō;* Lat. *misceo;* Polish, *mieszam;* Bohem. *smīsseti;* Eng. to *mash mix*; Ger. *mischen.* Heb. *mashash*, to feel; Arab. idem.; Gr. *massō.* Heb. *na'ar*, boy, feminine *na'arāh*—no doubt this is a primitive noun, in Sanskrit *nara*, man; *nari nare*, woman; Zend, *naere;* Persian, *nar;* Greek, *anēr.* Heb. *naphal*, to fall—the root is the same in Chaldee and Syriac; and the primary syllable, *fal*, appears in the German *fallen;* Eng. *fall*; Gr. *sphallō;* Lat. *fallo;* Sanskrit, *spaladini.* Heb. *saphad*, to beat the breast as a sign of grief; Gr. *sphadazō.* Heb. *'avar*, to pass over; Arab. idem.; and as a noun, *shore;* Ger. *ufer;* Sansk. *upari;* Pers. *aber*; Gr. *huper, pera, peran, peraō;* Latin, *super;* Gothic, *ufar, afar;* German, *über;* English, *over.* Hebrew, *'aitz*, a she-goat; Syriac, *'ezo;* Sanskrit, *adsha*, he-goat, *adshâ*, a she-goat; Gothic, *gaitsa;* Anglo-Saxon, *gat;* German, *geis;* Greek, *aix, aigos.* Hebrew, *gamal*, camel. This word, like the last, appears in all the Semitic languages, and very many of the Indo-European, and it is evident from this circumstance that the camel and the goat, as well as the horse, were domesticated before the separation of the Semitic and Aryan peoples. Horse is in Hebrew, *parash;* also Arabic, *fărăs;* German, *pferd*, *d* for *s;* English, *horse*, *h* for *p* and *f*, as in Latin *facere;* Spanish, *hacer*, *h* for *f*. So also Heb. *par*, a young bullock; German, *farr;* Anglo-Saxon, *fear*. Hebrew, *'ēpher;* Arabic, idem. calf; English, *heifer*. The raven, Hebrew and Arabic, *'orēv;* Sanskrit, *karawa;* Greek, *korax*, evidently received its name during the same period; and here we must include the Hebrew *shōr*, ox; Syriac, *tora;* Greek, *tauros;* Latin, *taurus;* German, *stier;* Gothic, *stiur*. The Arabic and Chaldee agree with the Hebrew and Syriac. Hebrew, *padar*, like the Arabic *fadan*, means to fatten cattle, and appears in the German *futter;* English, *food*, *fodder*, *fat*, *fatten;* Icelandic, *feitr*. The primary root being *fad*, to which *r* is often added, as *pita*, *pater;* *pigeo*, *piger*. The common ancestors of the Aryan and Semitic nations gave the same name to the sun: in Hebrew, *shemesh;* Arabic, *shams;* Syriac, *shemsho*. The word is found under the radical letters *sm*, *sr*, *sn*, *sl*, in very many languages, as in German, *sonne;* English, *sun;* Latin, *sol;* old German, *summe*, whence summer; Sanskrit, *sura*, *surja*. In Hebrew, *rasas* means to moisten or sprinkle, whence *resīsīm*, dew-drops, of such excellent use in irrigating the ground before artificial means were invented, so we find the corresponding terms in Sanskrit, *rasah*, dew; Greek, *ersē;* Latin, *ros*. The sack and the horn were necessary instruments in the earliest days of man's existence, and so we find identical terms for them in most languages; thus, in Hebrew, *keren*, a horn, and so in all the cognate languages; and in Greek, *keras;* Latin, *cornu;* Sanskrit, *cringam;* Gothic, *haurns*, whence English, *horn;* and the word *kāneh*, a reed, seems to be of the like early use; in Greek, *kanna*, *kannē*, *kanē;* and English, *cane*. It occurs in early Hebrew (Jos. c. xvi., v. 8) as the name of a town. It would seem that the first inhabitants of the world were not ignorant of music, *shīr* in Hebrew meaning to sing, and finding its equivalent in the Sanskrit *shûr*, also to sing; the harp (perhaps the Eolian) being named in Hebrew *kinnor*, finding its root in *kanar*, to give forth a tremulous sound, whence Greek *kinura* and Latin *gingrina*. The Hebrew root *shīth* is found also in Syriac and Chaldee, signifying to put, set, place, &c., and is of very extensive use in the Aryan languages; Sanskrit, *stha;* and in the Greek words *histēmi*, *stoa*, *stēlī*, &c.; Latin, *sto*, *statuo*, *statura*, *stabilis*, and scores of other words. It is also found in English, German, and all other Teutonic, as well as in the Neo-Latin tongues; from the Hebrew root is derived *shathoth*, columns, metaphorically applied to princes and nobles; and the Chaldee *shuth*, a derivative of the same root, is foundation; and the name Seth is also a derivative, meaning set or appointed instead of another.

The numeral adjectives are commonly and very properly adduced to prove the relationship of languages, and at least five of the ten integers can be shown to be the same in the Aryan and Semitic families of speech. Thus, *echad*, one, in Hebrew and its cognate tongues, has the same radical letters in the Pehlevi, *advek*, and without *daleth* (d), in Sanskrit *eka*, and Pehlevi, *jek*. Heb. *sh'nayim*, two, Arab. *atnan*, Syr. *taren*, Chal. *terain*. The primary form appears to be *tenī*, and this has been softened to *dwi* in Sanskrit; Gothic, *twa*, Greek and Latin, *duo*, and German, *zwei*. Heb. *shalosh*, three, Arab. *thalathah*, Chal. *telath*. The primary form seems to be in the Zend, *teshro*, and transposed from this both Chal. *telath* and Greek, *treis*, Lat. *tres*, Sanskrit, *tri*, one liquid taking the place of another. Heb. *shēsh*, six, of analogous form in other Semitic languages, and in Sansk. *shash*, Zend, *qswas*, Slav. *schest*, Gr. *hex*, Lat. *six*. Heb. *sheva'*, and so both Syr. and Arab., Sansk. *sapta*, Goth. *sibum*, Ger. *sieben*, and Eng. *seven*. It is also probable that *five*, and other numbers in Hebrew and the Aryan languages, were originally the same, but as the analogy is not so evident as in those already adduced, and as five out of the ten numbers are amply sufficient, I shall not trouble the reader with analogies which might tend rather to perplex than to instruct him. There are multitudes of other words in all the parts of speech in the Semitic family which find their equivalents similar both in form and meaning in the Aryan, a fact of which everyone may convince himself by a careful perusal of Gesenius's excellent 'Hebrew Lexicon,' which has furnished most of the examples already quoted; but it would be useless to increase the number of words here, as those already produced are more than sufficient to prove that all the Aryans and Semites once spoke the same language, and consequently, that they did not spring originally from different centres of creation, but rather constituted a single family, originating in one locality. It would be interesting now to inquire whether the numerous dialects of Asia, Africa, the Polynesian Islands, and the aboriginal tribes of America would bear the same test, and thus prove that all men are members of one family—the descendants of one parent; but this task must be deferred, as it has no connection with the problem now under consideration. I presume, however, that it can no longer be doubted that the Aryan and Semitic peoples sprung from one stock, and in order to account for the great varieties in their several languages, it is necessary to suppose that a separation of the two great families or divisions happened in a very early period of the existence of mankind, and that then the languages of both families grew gradually and expanded, without having any material connection with each other, from some original tongue consisting of a very limited vocabulary, and few or no grammatical inflexions.

What an immense number of ages must have revolved in their ceaseless progress in order to develop this mere skeleton into such a fine body of language as we have evidence that Sanskrit on the one hand, and Hebrew or Arabic on the other, had assumed more than three thousand years ago. It is a fact capable of demonstration, that in this remote period there existed as much dissimilarity between the two families as at the present time, both as to their vocabulary and grammar; that is, there was no closer resemblance between Hebrew and Sanskrit than there is between Arabic and Greek at this day, after the lapse of three or four thousand years. Nevertheless, the mutations in all these languages have been exceedingly slow; Arabic, for instance, having scarcely yet arrived at that state of analytic decay at which Hebrew had arrived in the days of Moses; and yet when Hebrew was a living language it sustained scarcely a dialectical change during the period of a thousand years; and when we consider that Sanskrit and Hebrew must have gradually developed themselves from mere roots into the magnificent trees to which they may fitly be compared, and that thousands of years have been insufficient to produce any radical change in them, what an incalculable number of ages must have elapsed since they first began to grow, gradually advancing to synthetic maturity, and then as gradually decaying in structure, till we find their living representatives as Greek and Arabic, although much changed, still retaining all the more remarkable characteristics of their cognate tongues.

There is no reason why I should confine myself to Hebrew and Sanskrit for illustration, except for the sake of brevity, for the same phenomena are observable in Greek and other languages which have come down to our own times. Indeed, it is well known that Greek has retained the great majority of its ancient words and much of its synthetic character to this day. The spoken language has of course assumed a more analytical form, but it has undergone so little *radical* change, that Thucydides, for instance, would find no difficulty in reading Tricoupe's 'History of the Greek Revolution:' in fact, the two authors have been compared with each other as to style and language. The changes, then, which Greek has experienced have been very gradual, like those of Hebrew and Arabic, and the same may be predicated of many other languages.

And now, if we should illustrate the matter by a diagram, the best form would be an acute angle, the extreme points of whose two sides are very distant, one point representing the Aryan family of languages, and the other the Semitic; and although the extreme points of the two sides might be thousands of miles asunder, the angle itself would be something like the angle of parallax of a fixed star.

The problem would then be to calculate the length of the sides which represent the ages elapsed since the two families set out at the angular point in their progress down the two sides till they arrived at their present position at the end of each line. This line reduced to time I have no hesitation in affirming would represent not only thousands but tens of thousands of years.

VII. ON CELL LIFE.

By Dr. A. Fick, Professor of Physiology and Zoology, Zurich University.*

Plato, the profoundest thinker of the ancients, has already compared the State with a human organism. The several organs of the body represented, according to his ideas, the different vocations of the citizens.

Such conceptions, however fanciful they may seem, have nevertheless invariably tended to advance politics; and again at the present time, the renowned lawyer Bluntschli is endeavouring means to secure for his system profounder deductions and reasoning.

The comparison is really something more than a mere play of fancy, but it is better to illustrate the existence of the animal body by the State, than the existence of the State by the animal body. The points touched upon in the comparison are sufficiently apparent in the State, but in the animal body they are to a great extent concealed. The comparison, too, is a more fruitful one for the physiologist than for the politician. This will be seen from the following remarks, whose aim is to render apparent some of the fundamental relations of the animal economy by means of the simile of the State.

We do not assert that the State is comparable with an animal body; but the converse, the body of one of the higher animals is comparable to a governed nation. If this expression has any real significance, it involves the supposition that the body of the higher animals is made up of individuals, which, like the individual persons of a nation ruled by the State, are in some respects entirely and essentially alike. This supposition has at first something so strange and startling in it, that I must at the outset seek to render it more familiar to my readers.

What then can be these perfect individuals in the animal body? The answer to this is easy: They are the cells.

In order to show at once that I do not stand alone in this view,

* Translated from the German by E. Ray Lankester.

I would remind the reader of the opinion of a well-known labourer in the minute structure of the tissues, Professor Frey, of Zurich, who says of cells, in his 'Handbook of Microscopic Anatomy,' "they represent living beings, both as regards their anatomical and physiological individuality." But what is a cell? To this question it is by no means easy to give a reply. A full and clear definition of a cell is not yet possible. Let us try, by the help of observation and dissection, to form an idea of the nature of a cell. It is well known that the organs of animals and of plants do not consist of a homogeneous mass, but are formed of separate parts which have definite forms and properties. The elementary components of one of the higher animals or plants are various in their character, as the microscope teaches us. Many tissues consist of solid filaments, others of pipes or tubes, which are filled with contents readily distinguishable from the tube-walls. These elementary parts may exhibit, in their fully developed condition, great variety and differences, but in the earliest stages of development they are not distinguishable from one another.

Where a tissue is about to be developed, a number of small bodies are observable from the commencement, always wonderfully alike in form. They appear to be rounded lumps of a thick slimy substance; somewhere in the inside of each lump there is a clear, well-defined, and somewhat transparent globule, with a dark spot in the middle. Such a body as this is called, in the restricted meaning of the word, 'a cell;' the transparent globule within it, 'a nucleus;' and the dark spot in the middle of the globule, 'the nucleolus.' The formation of the most complex tissues of the animal body takes place in the following manner only: The original component cells multiply themselves. This multiplication takes place (as far as sound observations have ascertained) entirely by the subdivision of the mother cells, a process which is continually going on; the nuclei divide so as to separate the nucleoli into halves, and the surrounding material draws itself together into two masses around each of the newly-formed nuclei, and at last the masses become detached from one another.

Connected with the preceding statement, there is a most important question, relating to our knowledge of organic nature, in regard to which a lively contest has lately been renewed. The question is, whether individual creations of organic beings occur. Here the problem comes before us in a still more general form—namely, are there special creations of cells. The most reliable observers at the present day are agreed that the creation of a cell in an animal tissue has never yet been seen with certainty, and that each cell is the offspring of another, from which it has separated by division. Here, then, we have already decided evidence that the cell is to be regarded as an organic individual.

In the development of a tissue, the newly-formed cells increase by subdivision. They grow, according to the character of the tissue, into various forms, and in most cases secrete the materials which they have elaborated within their walls. Generally they become compacted together on the surface, and in many tissues in a fully-developed condition they constitute the chief mass of the whole tissue. Always, however, as long as the tissue is living, there must still remain those bodies, which are cells in the true sense of the word—the little lumps of that mysterious gelatinous matter which has in recent times been called Protoplasm. It is probably within this substance that the final problem of organic life lies concealed. Its peculiarity does not consist in its shape, but in the substance itself; for wherever it is, in whatever form it may occur, *there* we have manifestations of organic life. The *chemical* and *physical* properties of this protoplasm, as far as we at present know, are to a great extent passive (probably it is a compound of different chemical bodies, among which albuminous or white-of-egg-like substances are the most prominent); all the more remarkable therefore, are its *physiological* actions. Above all, it is important to keep this fact in mind, that wherever a separate piece of this substance is found growing and developing, it is (in accordance with the nature of the procreation of cells described above) a portion separated from another protoplasmic mass; in no case, so far as reliable observations have extended, is it ever spontaneously developed from its constituents.

But what is it that gives us a right to the paradoxical supposition that each protoplasmic lump, individualized by its central globule or nucleus—each cell, in the animal body—is a separate animal *subject*, with individual animation? In fact, I ascribe to each cell, not only of the animal, but also of the vegetable body, *animation* in the truest meaning of the word. To express my view as clearly as the obscure nature of the subject will admit, I am of the persuasion that this thing which *objectively* appears to us as a microscopic, minute lump or knot of gelatinous matter, is in itself, *subjectively*, a thing, similar to our own personal self; a thing conscious of the influence of other things (*sensative*), and of its own influence on other things (*volitional*).

I cannot but feel certain that such a stretch of the idea as this will be received by most persons simply with an elevation of the eyebrows and a shake of the head. Materialistic views of the world, at the present day, exercise a very widely-spread dominion, even in the minds of men who are, in fact, continually repudiating the ultimate consequences of materialism. The materialist's view of the world is simply an instance of one-sidedness, since it is a concession of existence to those things only which are *objectively* apparent—which are regarded by him merely as passive masses of matter in the network of causes. Those who view the world from a materialistic aspect assume the right to deny that the things which are yet beyond our experience possess in themselves an existence as *subjects.* I will stop no longer to criticize this view of the world, nor will I further delay the continuation of my observations. I hope, also, without having placed the matter in the position of a certainty, that the reader will at least allow that an organic cell has a true subjective existence. One cannot with certainty prove the truth of this hypothesis; and indeed, at present, it must remain a supposition, because the inner being of the thing itself is not open to our experience. In the same manner, we cannot certainly prove the animation of another man. In point of fact, as a mere matter of experience, a man is nothing more than one of the numerous phenomena of our *objective* experience; that is to say, a something from which material influence on other matter proceeds, and which is obedient to the great network of causes. Nevertheless, it has not yet occurred to any reasonable man to deny the animation of another.

But what is it that makes us acknowledge the animation of another man, seeing that there is no direct experience about it? It is the following conclusion, derived from analogy, which makes us certain of it. The individual Self is not only subjective, but as a corporeal phenomenon it is also objective with regard to the sensitive perceptions. We see our hands and feet, we hear our own voice, and distinguish it from that of another person's; as also we see the limbs of other men, hear their voices, and so on. In the range of our experience, we find the deportment of another man exactly like the deportment of our own body, as far as it is objective to us; and hereon we found the certainly just analogical argument, "Because I and another man exhibit exactly the same deportment *objectively*, so do we agree *subjectively;* and because I inwardly know myself to be an animated being, so the other man also will be a similarly animated being."

Only once let us tread this path of analogy, and we shall find, as will be seen, that we can find no conclusion to the range of life but in the simplest cells. In fact, that one cannot stop at man is clear enough, and generally acknowledged. The higher animals, and especially those nearly related to us, are so much like us that it would be foolish to deny their animation. No one would be surprised at our ascribing animation, or understanding, or even reflection, to a dog or an ape; but if we descend lower in the catalogue of animals, the signs of mental or spiritual life become naturally less and less visible, yet the degradation is so gradual, that we are unable to stop at any point in the list, and say, "Here animation ceases and the simple machine begins."

If we once ascribe animation to an ape, we must allow a polyp or an infusorium to be an animated being. Of course no reasonable man will overlook the enormous difference in the degree of animation in different animals. No one will suppose for a moment that any infusorium can form a clear idea of the objects in the world around it. To this faculty belong certain complex apparatuses, which the infusoria do not possess. The clearness of their consciousness certainly does not even nearly attain to the clearness of our consciousness when in the deepest sleep; but as there is a regular and gradual transition between sleeping and waking, so is there between the degrees of animation in different creatures. The comprehension of spiritual matters, the amount of consciousness, the lucidity of the ideas produced by objects in the external world, vary interminably; but the essence of the thing remains the same, even in the very lowest grades of the organic kingdom. There is, in every case, a feeling of self-separateness or individuality, distinct from the outside world; the active influence of that world is felt, and upon it the *subject* desires to direct its influence.

There is no doubt that this proposition is clear enough to all who rank themselves as disciples of Darwin as regards the origin of species. For this philosopher surrounds, as did the ancient religion of the Indians, the whole organic world with the bands of brotherhood. I have, however, purposely avoided grounding my argument on the doctrine of that teacher, because it cannot yet be held as a proved scientific truth. So, then, if it be once admitted that animation extends downwards into the lowest forms of the animal kingdom, then it is also admitted that *there exist single cells, which are to be reckoned individually as animated beings;* for there are numberless animals belonging to the order infusoria which consist of a single cell. Such an animal, for instance, is an Amœba, a minute, microscopic, protoplasmic mass, with nucleus and nucleolus. If its actions are observed under the microscope, one can see how it alters the form of its body at will; how it sends forward prolongations here and there, draws out the mass of its body, and so changes its place. On outward irritation, it generally rolls itself up into a bullet-shaped lump, and rapidly draws in again all the prolongations lately stretched forward. Often one may observe it engulf smaller bodies in its substance, where they are changed—one may say, digested—and half disappear, the undigested leavings being again ejected. The little animal grows, and goes on propagating itself by division.

A cell which belongs to the tissues of one of the higher animals behaves exactly in the same manner as a single-celled infusorium. For example, in the blood we have cells; the so-called white blood corpuscles, which are exactly like certain infusoria. Thus they stretch out prolongations of their substance subject to their will, and upon irritation and the like they show the well-known reactions. The cells in connective tissue deport themselves similarly. They crawl regularly about in certain chasms in the substance of the tissue formed beforehand, which they elaborated for themselves, which, in fact, they have constructed as their dwelling. What is particularly worthy of attention is, that these cells when they have left the tissue, can move themselves for some time in a fluid, and show all the phenomena described. These facts are truly among the most beautiful acquisitions to our knowledge lately derived from microscopic research. They had for a long time escaped the attention of microscopic observers, because animal tissues were not examined under the same condition in which they exist in the living organism. It has already been mentioned that cells in the tissues of highly organized animals are exactly the same in their growth and reproduction as single-celled organisms. And, in the last place, to complete the identity, all the cells of a whole animal are actually the brood of one single cell—namely, the ovum. We have here before us exactly the phenomena which we regard as the characteristics of an animated being—movement at will, and reaction on outward irritation. Thus, then, we can by a well-connected chain of strict analogies arrive at the proposition which was placed before us. Each cell, whether it be an independent animal or part of the tissues of a higher organism, is in itself, *subjectively*, an animated being. The want of self-dependence in the cell, which forms a part of the tissues of a higher animal, is really not greater than in the single-celled infusorium, which lives freely by itself. In fact, each organism has its own conditions of life; and as the tissue-cells can only live, for any length of time, in a certain fluid, or in their appointed self-wrought habitation, where they dwell as a compound organism, so can certain single-celled infusoria live persistently only in certain fluids; they also die if placed under conditions to which their organization is not adapted. I am not, moreover, at all certain, as before said, of the impossibility of a cell, if once removed from the blood or connective tissue of a higher animal and placed in another soil (as it were) under favourable auspices, proceeding with its life as an independent animal, and becoming the mother of a brood of infusoria.

From the standing-point which we have now gained, we cannot call an organism which consists of more than one cell an individual. Such an object is much more like an association of individuals, which live together in a habitation wrought by them. The cells have themselves secreted the materials for building from their bodies. Association makes a division of labour possible. It is no longer necessary for each cell to execute for itself every organic function—digestion, assimilation, &c., in their different stages. One group is able much more satisfactorily to execute this, and another that office for the whole household; and thus the particular functions are brought to greater perfection, and the performances of the entire organism become more varied and numerous.

The best type of such an association of organic individuals is a plant. Here we see different groups of cells execute different offices which benefit the whole plant. One set extracts material from the ground, another elaborates it in various ways; others again draw material from the air; others are especially fruitful in producing new generations. But we do not attain to the higher efforts of physical activity in the plant. The reason of this is easily seen.

In plants, each single cell surrounds itself directly with a membrane of the so-called cellulose, the substance which we have before us in wood, in cotton, and in paper. The cells are, by means of this, individually shut up; they can, it is true, influence one another to a certain degree, in that they can transmit material to one another; but they cannot influence one another to an unlimited extent; they cannot share their conditions, their sensations, we may even say their experiences, with one another. Each therefore is confined to the bare circle of its own sensations (which we are as little able to dispute in plant-cells as in animal-cells), and therefore it can reach to no higher grade of psychical life.

The cells of a plant are, in a word, like a number of men shut up from childhood together in a cellular prison, who perhaps might have exercised much important influence on one another, but between whom all spiritual intercourse has been prevented. These men would never display the deeper characteristics of spiritual development.

In the higher animals there are numerous groups of cells which are disposed in a manner analogous to that observed in the plant cells; that is to say, they lie isolated, yet near each other, though not enclosed in the same hard dwellings as in plants. Such aggregates of cells, for example, are the blood and the epithelium. The epithelium is the name given to the layers of cells which lie arranged like strata wherever an organic structure is bounded towards external space, as in the outer skin (epidermis), and the slime-skin or mucous membrane which lines the surface of internal cavities open to external space. Many other tissues also form the same kind of cell-masses, upon the principle of the plant's organization. Their action has been long designated as 'vegetative,' correctly referring to the analogies which they present to plant-life.

In the higher animals a new system of cells is added to this vegetative group, which are disposed on a totally different plan. It defines what is truly *animal*, and its actions are rightly designated 'animal.'

In fact, the difference between plants and animals does not really lie in their elementary components. Both kingdoms are, as we saw, and as most observers in both now admit, constructed from elements of a similar nature—from cells. Among the simplest organisms, philosophers have been in much doubt in which of the two kingdoms they shall place those beings consisting of but one or few cells, and perhaps there is nothing to justify the assertion of a sharp boundary. The distinction can only be clearly shown where one has to deal with complex organisms formed of many cells. The true characteristics of the two kingdoms are to be found in the manner in which the colony is built up by its individuals, and thus especially in that system of cells just mentioned which gives its peculiarity to the animal kingdom. This system is a series of cells widely spread through the whole body, in which the protoplasmic matter is maintained in unbroken continuity throughout, by fine, long threads. It is the 'nervous system.' Let us consider this wonderful structure somewhat more closely, and indeed let us bring it before us in that form which it takes in man, the highest of now known animals. The cells of the human nervous system are generally packed together in more or less numerous groups, which are called nerve-knots or ganglia, whence the name ganglion-cell is derived for the cells of the nervous system: they are simply, as all cells are, nothing more than protoplasmic lumps with nucleus and nucleolus. The nervous ganglia lie distributed over the whole body, in some places sparingly, in others profusely, and are bound together with connecting cords of the protoplasmic thread, which, as was said, always brings two cells into conjunction. Each such protoplasmic thread is encased in a true sheath, and forms with it what is called 'a nerve-filament.' It must further be noticed that each cell commonly is connected, not only with one, but often with many other cells by means of nerve-filaments.

Besides these filaments, which establish the communication of the nerve-cells among one another, there are others which communicate at one end only with a cell, and at the other end are connected with structures of a different nature. There are two sorts of these filaments, differing very much in kind, though not in their essential nature. The one set—in the strictest meaning of the word—proceeds outwards from the organs of sense, and is destined to convey external impressions to the nervous system. The others, which terminate in the muscular fibres, are appropriated to carrying the active influence of the nervous system to the exterior.

We have now a complete picture of the nervous system in man, when we add that in him, as well as in the four higher classes of animals, by far the greatest number of the nervous elements—that is, of nerve-cells and connecting filaments—are packed together in a continuous mass, and shut up in the canal of the backbone and those cavities of the skull which are continuous with it. These great nervous masses are known as the brain and spinal-cord.

The construction of the nervous system makes it very clear that something takes place here which differs from what occurs in the plant or plant-like tissues of the animal. The nerve-cells cannot only work externally, and operate on one another, by modifying the fluid in which they are placed; they can work upon one another much more directly by means of their connecting filaments of protoplasm; they can mutually communicate their conditions, which as material appearances are called conditions of irritation, but which from their own stand-point are sensations or acts of the will. Here, too, the means are provided to enable a cell (that is to say, an organic subject) to be sensible, not only of that which operates on itself alone, but also of that which affects a thousand other cells continuously connected with it. Thus a cell can learn (if the expression is not too strange) by the experiences of others. Through this it becomes possible for the conditions of animation to attain to that high perfection, in virtue of which the consciousness awakens to that clearness which we experience in ourselves.

The comparison of our body with a State is now no longer a difficult matter. The cells of the vegetative functions constitute a race as it were of mentally-stunted people, among whom each man lives shut up by himself, without knowing much of his neighbour. The epithelial cells of the intestines we may more particularly compare to the agricultural classes, who derive nourishment for themselves and for others from the ground. They give this raw material to the blood-cells, which represent the mercantile classes. These disperse it over the whole State, but are certainly bad tradesmen in the common view of such matters, since they exchange their valuable commodities for nothing but used-up rubbish, which they must dispose of as quickly as possible to the appropriate organs, the lungs and kidneys.

This laborious population bears the yoke of an aristocracy, and submits to be governed by it. I mean the nervous system. There is within this aristocracy a strict system of caste, or I might perhaps better say, a bureaucratic classification. It has also to maintain a standing army in the muscular fibres, and must hold it ever ready for action, for our State is never at peace, and indeed must continually be fighting with other States, and with the forces of nature in the doubtful battle of our existence. The highest place in our aristocracy is not held by a monarch, but by a body of equals. They are the ganglion-cells of the great cerebral hemispheres which so largely constitute the upper part of the nervous system. Here all the filaments meet, here all intelligence arrives at last, and hence proceed the most important decrees to the whole nation. But it must not be supposed that all the sentient filaments of the more highly sensitive organs, of the skin and so on, pass directly to the cells of the great hemispheres of the brain, and that the motor nerve-threads go without interruption hence to the muscles. On the contrary, there are placed between the periphery and the great cerebral hemispheres, as mentioned already, a lower authority of the bureaucratic mechanism. This is the accumulation of ganglion-cells in the spinal-cord and mid-brain. Especially in this last part of the nervous system, and in the so-called 'medulla oblongata,' in the places where the great nerves of sensation flow in, there are masses of cells representing the highest executive officials. Here the raw materials of sensation are arranged. Here the scraps of news out of the various provinces of the kingdom—that is to say, the sensations from the various authorities on feeling—are brought together and are worked up into abstract conceptions, which are then delivered to the higher body corporate. This finally determines what is to be done in consequence. If a resolution is here carried by a majority, these powers immediately give directions to the subordinates, without entering into details. The resolution is merely a sign addressed to the lower authorities, who then elaborate the details of action and operate upon the nerves distributed to the muscles. For example, a determination is made when in great pain to pronounce a certain word: to effect this, a complex series of movements are necessary, for which purpose a certain number of muscles are disposed consecutively. There must therefore be a number of motor impulses sent from the brain along various lines of nerves; but these motor impulses do not proceed as such from the great cerebral hemispheres, where the resolution is first made. From thence only a simple sign is given, which is at once understood by the wonderfully trained subordinates. These officials are the groups of cells in the medulla oblongata, from them arise the motor nerves of the respiratory apparatus and of the tongue. Here the mandate, indicated by a sign, becomes methodized into various single orders, and now the winged messages go here and there along the various motor lines, conveying the fiats of authority.

The inferior authorities of our bureaucratic mechanism rejoice in the possession of a certain amount of independence. For example, there is that group of cells which is related to the mechanism of respiration. They are continually sensible of the necessity of ventilation for the blood, and thereupon determine to set the bellows in action, more or less quickly, according to the requirement. Most probably the brain receives information of these proceedings, because threads pass from the said cells to it. It can even take an active part in them, since we could form the determination in our central consciousness to arrest the breathing. The servants, however, would not attend to such a selfish command on the part of the supreme power.

The subordinate powers can also act independently upon external impulses. Let us take the effect of ammonia on the mucus of the nose. The cells in the medulla oblongata feel it, and command the subservient muscles of the thoracic cavity to throw off the irritant by a violent expiration, an act which we generally call sneezing. Such actions, which can take place without the intervention of the superior hemispheres of the brain, have been called 'reflex actions,' as distinguished from actions of the will.

Reflex action is best studied when the cerebral hemispheres have been entirely removed. In some animals this is quite possible without destroying those parts which enable them to move under the influence of external irritation, but the movements then executed are observed to differ from those which occur upon similar irritation when the cerebral hemispheres have not been removed. The various phenomena which have been observed in the actions of animals under these conditions, prove that the spinal-cord is a centre of animation, and the objections of many philosophers against its animation might just as well be urged against that of the brain, if they were in reality valid objections. They say that each of these phenomena can be explained as simple mechanical actions, but *we* are certain that things have an existence independent of our experience, and that this existence in organic individuals is sensation, will—in fact, animation.

Let us now look at the matter from this point of view, which is not the one generally adopted in natural science, but which the interpreter of nature may well accept at once, when he has laid down his dissecting knife. Thus we shall obtain a new signification for some of the phenomena referred to. An uninjured animal—a frog, for instance—makes a spring upon irritation of the skin, because in the cells of the great brain, consequent upon the experiences of the skin and also those of the eye, which are subject to the brain, a supposition is founded that a spring protects the animal from threatened danger; but, on the contrary, if the cerebral hemispheres have been destroyed, the cells of the spinal-cord have to take the lead, and because they have not so much material of knowledge at their command, seeing that they can derive no information from the higher organs of perception, they are unable to form the determination and carry it out, of making a trial of flight. They are only able to give the order to the nearest agent at hand to remove the irritation. This is the foot of the animal, which is accordingly raised to the place subjected to irritation, for the purpose of removing its cause. Thus, then, the subordinate centres of the great cerebro-spinal system become perfectly independent if the superior centres are destroyed. In the course of normal life, they have, on the other hand, as has been already stated, only a relative independence, their commands are only executed when counter-mandates are not issued by the higher centres.

In the ordinary course of life a much greater independence appertains to those subordinate nervous centres which lie scattered over the body, and are placed as guardians of the vegetative activity, such, for example, as the nervous ganglia of the heart and intestinal canal. It is only occasionally, under very exceptional circumstances, that painful news reaches the higher regions from these quarters; it is only in illness, or when an unusual storm of sensation is raging. such as fever, anxiety, and other passions, that any influence from above operates on the beating of the heart. It is worthy of notice that among the connecting threads which contribute to the weak dominion of the brain over the nervous centres of vegetative life, are particular cords which have the exclusive function of conveying counter-mandates against action. These are the so-called nerves of interception. These are capable of conveying such an irritation as to bring the heart to a stand-still.

Among the inferior nervous centres a division of the work into departments occurs, as has been shown by examples. One mass has to elaborate the sensations produced by light into vivid representations; another has to connect these with the sensation of touch; again, another has to do with speech; others arrange the movements of the various extremities; others the throbbings of the heart, and so on. Nothing decidedly analogous to this takes place in the supreme governing body—the cell-mass of the great cerebral hemispheres. Here every cell can participate in every opportunity which is afforded for the activity of the general cerebrum. Each part of this organ, larger or smaller, can set the other parts into action, especially since there is a definite relation between one great half of the brain and the other. These are positive facts which cannot be doubted. In fact, there are numerous pathological observations which show that though men have frequently, either by external injury or destructive disease, been robbed of the greater part of their cerebral hemispheres, yet it has never been remarked in such individuals that any mental power, such as speech or memory, according to the locality of the wound, had been lost. A man, with the greater part of his cerebrum destroyed, rejoices in the same clearness of consciousness and understanding as before. These observations alone would be enough to upset the idle speculations of "phrenologists," were that consummation not already attained by their unreasonable classification of the so-called "mental properties."*

The facts in question enable us to add one more observation worthy of notice. They show that the acuteness of the understanding, and generally the quality of mental power, does not depend upon the quantity of brain, which, however, is a view widely accepted. Nevertheless, the *energy* and *unweariedness* of mental activity seems to depend upon the mass of the brain. In our way

* "Seelenvermögen."

of looking at the question, it must be so, as a matter of course, since when only a small number of cells are at hand, each single cell must be more strained than when many are present to relieve one another. In the first case, the whole mass would speedily become exhausted.

Thus it is, that we find it an acknowledged fact, that the greatest men as a rule have very big heads. It is explained by the consideration that to illustrious actions belong not only activity, but also steady energy and endurance in their accomplishment, which qualities simply depend on the size of the cerebral mass. In the course of our observations, I must freely admit, in conclusion, we passed over an obscure point—namely, How is it that to us our own consciousness seems personal, whereas, according to the representations made above, it should be rather the united consciousness of a people? I know no solution of this problem, excepting a masterpiece of human wisdom from Kant's 'Critique on Pure Reason.' It is this:

"An elastic ball which strikes another divides with it its whole momentum, consequently, its whole phase of being. Suppose, then, an analogous case, in which bodies of like material are concerned, the one imparting to the other *ideas:* a whole series is easily conceived, in which any one which may be regarded as the first communicates to a second its conditions and the consciousness of them; the second acts similarly on a third, communicating, not only its own conditions, but those of the first also; whilst the third in like manner communicates the conditions of all the preceding ones together with its own, and their consciousness. The last body would thus be conscious of all the phases of being of the bodies that had been modified before it, as well as of its own, because these phases of being were transferred to it together with their consciousness, and in consequence of this, would it not have been identically the same individual in all these phases of existence?"*

Is it not as though the great thinker had flashed forth the then undiscovered construction of the nervous system, with its *cells sharing with one another their conditions.* Verily, the veil is as yet but just touched. It still remains impenetrably thick over the secret depths of our inner selves, and so will remain to the end.

* The utterances of great thinkers are ever suggestive. If we have a row of elastic balls touching one another, and give a blow to the first, it will impart its momentum to the second; that will affect the third, and so on, with gradually-diminishing intensity, until the last is impelled slightly forward from the rest. But modern physics teach us that each ball will have been affected in another way. If the force, the motive impulse, has diminished in its passage through the balls, a little heat will have been set up, in conformity with the law of the Conservation of forces.

Thus, when the divine truth or energy is conveyed into the mind of a man who stands at the head of a series of thinkers, it fires his brain; but he imparts the "momentum" to his neighbour, and the influence passes from mind to mind, probably with diminishing vigour, until it reaches the last mind—that which offers the least resistance; for there is none lower to whom it can communicate it; and so *it* is not fired, but moved a little forwards: that last mind is the mind of the masses.—Editors.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

The Cattle Plague.—This has continued the overwhelming interest of the past quarter in the agricultural world. Advancing for many weeks at a very rapidly increasing rate, and having attained a fatality of about 1,500 cases daily, it has latterly been stationary; and we hope it is at length feeling the influence of the means which have been employed for its prevention and restriction. The Cattle Plague Act requires the immediate slaughter of affected animals, and permits the local authorities to destroy those which, having been in contact with the plague, may be supposed to have become infected. The rapid breeding and spread of the poison are thus at length in some measure stopped; and we may hope with some confidence that the hitherto rapid extension of the plague has been checked. Every other method than the pole-axe for this purpose has hitherto been a failure. Vaccination, on which some hope had been built, was found to be no security whatever: and every published cure has hitherto, on sufficient test being applied, proved to be fallacious. Acids, alkalies, and salts have all been fairly tried, and all found wanting. Sulphuric acid, sulphates, and sulphites, hydrochloric acid, common salt, lime, salts of iron, sulphur, and a variety of drugs have all proved ineffectual. Mr. Worms, a coffee planter of Ceylon, who imagined the disease to be the same as he had often treated successfully in that island, confidently recommended onions and assafœtida in certain doses as a cure; and it has been largely tried, but without success. Baron Rothschild's herd at Mentmore was rapidly succumbing to the plague, notwithstanding Mr. Worms' treatment, when the experiment was at length cut short by the intervention of the law for slaughtering affected animals. Homœopathic treatment seems, according to the published tables, to have achieved a larger proportion of success than any other. But everybody knows the extreme untrustworthiness of any general conclusion on this subject built upon an insufficient basis of examples. Meanwhile, the fatality of the disease, which, on its first appearance, was extreme, and is still extraordinary, has been gradually diminishing. The recovery rate, which was only 5 per cent. in October, and 6 per cent. in November, over the whole number of cases reported since the beginning, had risen to 11 per cent. in the third week in January, and stood at 12·146 per cent. on February 3, 12·364 per cent. on February 10, 12·680 per cent.

on February 17, 13,377 per cent. on February 24, and 13·956 per cent. on March 3. Since then the slaughter of all affected animals by law has, of course, hindered any further observation; but the plague was apparently obeying the law of other extraordinary epidemics, and gradually losing with extension the extremely fatal type which it exhibited at first. The above are the results of comparing, not one week with another, but the totals since the commencement of the attack up to the end of each successive week. The advance is very much greater if the experience of each successive week be examined by itself. The recoveries, which were only 848, or 4·8 per cent., at a time when there had already been 17,673 cases of the disease in the country, amounted to no fewer than 2,561, or 25 per cent., during a single week in February, when 10,167 fresh cases occurred. We may, therefore, declare that, great as this burden on British agriculture undoubtedly is, some hopeful signs connected with it are at length appearing.

It is, however, certain that they depend very much upon the great fear which the disease has created, and the extreme care now taken in isolating diseased herds. In a lecture by Professor Simonds, before the Royal Agricultural Society of England, the greatest emphasis was laid on the need of this carefulness, as the only hope of preventing the extension of the malady. Labourers, travellers, dogs, cats, pigeons, even the wind, when the disease is general over a considerable area, can carry the poison; and if a particle of the morbific matter gains a lodgment in the system of a healthy animal, it will develop there. Hence, wherever the disease exists, it is of the greatest importance that we detect it early, not merely because the only chance of successful treatment depends on commencing with it at the outset of the attack, but also because the establishment of a complete isolation of the animal, before it has begun to exhale the developed poison, is absolutely necessary. Professor Gamgee's researches prove that the symptom which precedes all others is a slight exaltation of the temperature of the body. A thermometer inserted into the rectum or vagina indicates a temperature of from 2° to 5° Fahr. above the normal 100° in a day or two after the inoculation of the animal with the poison, and some days before the characteristic outward symptoms show themselves. And the examination of whole herds has proved that the natural development of the disease is indicated in the same manner. The misfortune, however, is, that this premonitory symptom is true of other diseases also, so that all that any stock-owner can declare with certainty, on finding that the internal temperature of his beast, ascertained in this way, stands at 103° to 105°, is that its health is disturbed. If he fears the cattle plague he may be disposed to believe that it has at length reached him; but of this he cannot be sure until the other more characteristic symptoms appear. Meanwhile the necessity is urgent for the utmost care being maintained in disinfecting every person, place, or thing that has once been in contact with the disease wherever it has unmistakeably declared itself. Sheds, utensils, recovered animals, clothes, yards, manure, must be carefully disinfected or the plague will come again.

The disease has at length everywhere created fright enough to ensure the adoption of careful measures, and a wholesome public opinion having at length grown up, has declared itself in extremely stringent legislation, and we may therefore hope with some reason that we shall be able at Midsummer to report a diminution of the plague.

Among the other topics of agricultural interest which have arisen during the past quarter, we may name the first general attempt to collect the agricultural statistics of the country. Returns of the number of heads of various farm stock are being made this month by every occupier of land; and we shall soon know, with some degree of certainty, what are the numbers on which we depend for food, and what proportion to our actual stock is borne by the losses to which cattle plagues and other epizootics make us liable. A commencement having at length been made, we may hope that measures will by-and-by be taken for ascertaining and publishing from year to year the food-producing power of the country in the other important departments of its agriculture.

Mr. Alderman Mechi has read a paper before the London Farmers' Club on the tillage of the country, in which he declares its insufficient depth and general lack of efficiency in order to the full development of fertility. Plants go great depths for their food; and young crops are obviously benefited by hoeing and stirring the land during their growth. These are the two facts on which he bases his argument for the greater depth and thoroughness of tillage operations. The extension of cultivation by steam-power is one chief end to be desired, as being in itself the principal means to the attainment of such fertility as thorough tillage can develop.

Mr. Denton, C.E., and Mr. Grantham, C.E., have called attention to the great need of storing up in country places, for farm and village use, the drainage-waters of the neighbourhood. The want of water in many places, especially where either deep clay or deep chalk exists, is a very heavy agricultural burden and a great social calamity; and on both grounds the drainage-water, which is the very best available in such cases, ought to be stored in winter time against summer drought. The excessive rain-fall of the past season, following as it has two very dry summers, the difficulties arising from the drought of which will not soon be forgotten, makes the urgency of this question all the more apparent.

The Educational Committee of the English Agricultural Society have published the results of their first year's experience. No fewer than 120 boys, the sons of farmers or intending an agricultural life, competed for the Society's prizes at the recent Cambridge University Local Examinations; and it is believed that some agricultural interest has been excited, and some agricultural good therefore been achieved. We believe that the efficiency of the Agricultural Society's prizes will be much greater, and their results will be more immediate, when they are offered exclusively for such evidence as examinations can test of competency, proficiency, and excellence (not in the several branches of ordinary school training, but) in the several departments of a strictly agricultural and professional education.

The condition of the agricultural labourer under the systems of payments in "kind" and by money respectively has been discussed. In Dorsetshire the payment is very largely by perquisites of various kind—cottage and garden free, wheat at a reduced price, &c., and only partly by a weekly money wage; and only the last particular being published, an undue impression of the hardships of the Dorsetshire labourer has arisen. In many districts of Scotland, too, wages are to a great extent given in meal, in a cow's keep, and so on, and the result, they say, is advantageous for the labouring man. Lord Shaftesbury declares the advantages of the somewhat similar system in Dorsetshire. But these advantages are altogether denied by the Rev. Lord S. G. Osborne, another Dorsetshire philanthropist; and we entirely sympathize with the latter in the belief that, as we have no right to treat labouring men as if they were children, incapable of looking after their own interest, or to enforce a system of payment upon them lest they should waste their means, so also, any such enforcement tends to the maintenance of a childish helplessness and improvidence, out of which trouble and distress are sure to grow.

The report by Mr. Lawes, of Rothamsted, on the experiments undertaken for Government to determine the relative values of unmalted and malted barley as food for stock, has been published. From the extent of these experiments and the great care with which they were carried out, we should judge the result to be entirely trustworthy. And it clearly proves that the waste of nutritive material in the process of malting is so great, that whether the dry matter of malt or that of barley, by itself, be the more nutritive or not, there clearly is less food in the malt derived from a given quantity of barley than there was in the barley from which it was made.

II. ASTRONOMY.

(Including the Proceedings of the Royal Astronomical Society.)

Professor Grant, F.R.S., of the Glasgow Observatory, has been for some time past engaged in the determination of the difference of longitude between the Observatories of Greenwich and Glasgow by galvanic signals. The method adopted was that of double registration, which has been practised so successfully in the United States of America, and more recently in Europe. The principle of this method is extremely simple. When a star passes each of the successive wires of the transit telescope of the more eastern of the two Observatories, the observer, by tapping a key with his finger, completes a galvanic circuit, and the instant of transit is recorded on the chronographic apparatus of the Observatory; but the galvanic current, instead of going to earth, is made to pass along the line wire to the recording apparatus of the distant Observatory, upon which also the instant of transit is in the same way recorded. A process exactly similar is repeated when the star comes to the meridian of the more western Observatory, the instant of transit being registered on both chronographic apparatuses by the same completion of the galvanic circuit. In this manner each signalling star supplies two pairs of recorded times of transit, a comparison of the individual values of which gives two distinct results, the one indicating the difference of longitude between the two Observatories, the other assigning a value of the time occupied by the galvanic current in its passage from the one Observatory to the other. The period of operations extended from April 28 in the past year to May 26. The stars selected for observation amounted in number to twenty-eight, and were arranged in four groups of seven stars each, and in such a manner that when the last star of any group had passed before the telescope of the Glasgow Transit Circle, which was the more western instrument, the first star of the succeeding group was nearly about to commence its passage over the wires of the Greenwich or more eastern instrument.

The weather on the whole was not favourable for simultaneous observations at both Observatories during the period of four weeks over which the operations extended. In several instances observations were made at Greenwich which could not be responded to from Glasgow, and in one or two instances the converse of this happened. On four nights, however—May 1, May 2, May 22, and May 25—the sky was favourable for observation at both Observatories, and it is upon the results obtained on those nights that the determination of the difference of longitude is exclusively based.

Collecting together the mean values of the difference of longitude for the four days, we have

	Difference of Longitude.
	m. s.
May 1	17 10·680
2	10·648
22	10·433
25	10·463

Combining these together with a due regard to the number of observations on each day, we obtain for the definitive value of the longitude of the Transit Circle of the Glasgow Observatory,

$17^{m}\ 10^{s}\cdot 55$ W.

Similarly, for the time of the current's passage,

	s.
May 1	0·023
2	0·037
22	0·035
25	0·018

Whence we obtain definitively

Time of Current's Passage $= 0^{s}\cdot 029$

Proceedings of the Royal Astronomical Society.

M. Chacornac, in a letter dated 24th October, 1865, addressed to the President of the Royal Astronomical Society, refers to the continuation of his researches on the physical constitution of the Sun; and states that after various observations he has arrived definitively at the conclusion that the Sun is at least as luminous at its centre as in the brilliant envelope which bounds its visible contour.

The Society also received from Mr. A. Brothers a sheet of photographs of the Moon, taken during the Eclipse on the 4th October, 1865, with his Equatorial telescope of five inches aperture. Mr. Brothers writes that the prints must not be looked upon as photographs of the Moon, as many very much superior have been taken, but merely as pictures of the Eclipse. The atmosphere was so much disturbed during the whole time of the Eclipse that the sharpness of detail is lost to a great extent. He attempted to obtain the entire outline of the Moon, but failed to get more than greater sharpness of the shadow; this will be seen in No. 10, which was exposed fifteen seconds; Nos. 8 and 12 were exposed three seconds, and the remainder from one to about two-tenths of a second.

At the December meeting of the Royal Astronomical Society, Professor Grant gave a verbal account of his successful experiments in distributing accurate time over the City of Glasgow. He stated that, in the time-signalling operations at Glasgow, Jones's method of regulating clocks is exclusively used. It is generally known that, according to this method, the electric fluid is employed merely as a regulating agent, and not in any case as a motive power, the time-piece under control being an ordinary clock, connected by a regular succession of electric pulsations with the normal mean-time clock of the Observatory. The application of the invention in Glasgow has been perfectly successful. It has been employed under various forms; but what Professor Grant considered to be the most suitable to the requirements of a large city was the small clock with a seconds' pendulum and a dial of about three feet in diameter, showing the time to hours, minutes, and seconds. Clocks of this construction have been set up in the public thoroughfares of Glasgow, and have been found to be exceedingly useful. Attached to each of them is a galvanometer, which, by its deflections, gives an indication of the electric currents transmitted in successive seconds from the normal mean-time clock of the Observatory, and a break in the transmission of the currents, once in every minute, namely, at the sixtieth second, of the Observatory clock, supplies the public with an unerring criterion for testing the accuracy of the controlled clock. There were now eleven clocks of various forms in Glasgow under the electric control of the mean-time clock of the Observatory. In a short time the number would be increased to some seventeen or eighteen, and the system was gradually extending over all Glasgow. The going of these clocks was truly marvellous. From week to week and from month to month they continued to indicate the time with the utmost precision, requiring merely a little attention now and then to the battery power. It was one of the advantages of Jones's method of control that, even in the case where the operations were on an extensive scale, only a small amount of battery power was necessary. There was one other remark which he would make, and it had reference to turret-clocks. Hitherto it had been usual, in the operations for placing one of such clocks under control, to remove the two seconds' pendulum, and to substitute for it a seconds' pendulum, which was made to beat in exact unison with the pendulum of the Observatory clock. Objections to this practice have been expressed by many persons who consider that a heavy pendulum vibrating once in two seconds is much better adapted than a light seconds' pendulum for maintaining the steady going of a clock fitted up in a lofty tower, the dials and hands of which are necessarily exposed very much to the action of high winds. After a good deal of experiment, Professor Grant found that the two seconds' pendulum might be retained and kept under complete control by attaching a large wire coil to the bob, and using a more powerful system of magnets in combination with it.

Messrs. Warren De la Rue, Stewart, and Loewy have examined the Kew photographs of the sun, as regards the decrease of actinic effect from the centre to the circumference of the sun, which is, without doubt, caused by the presence of a comparatively cold solar atmosphere.

In conformity with their views, this atmospheric effect ought to be greater at the epoch of maximum than at that of minimum spot frequency; and furthermore, if there is any reference to ecliptical longitudes in the behaviour of spots—that is to say, if at any time the spots on the sun attain their maximum at any ecliptical longitude, there ought (according to these views) to be a greater amount of absorbing atmosphere at the same longitude, since such an atmosphere is supposed conducive to the outbreak of spots.

There is reason to think that spots attain their maximum in the ecliptical longitude opposite to that where Venus exists, so that we might expect (according to these views) a diminution in atmospheric effect in the same longitude as Venus, and an increase in their effect in the longitude opposite to Venus. If, therefore, Venus be at the longitude of the left limb of the Sun, this limb should exhibit less atmospheric effect than the right limb, and if Venus be at the right limb, we should have most atmospheric effect at the left limb.

It appears, from a joint and careful investigation of the Kew pictures by Miss Beckly and Mr. Stewart, that

(1.) When Venus is considerably to the left, there is most atmospheric effect to the right.

(2.) When she is in conjunction or opposition, there is a tendency to equality.

(3.) When she is considerably to the right, there is most atmospheric effect to the left.

Referring to these solar photographs, the President of the Astronomical Society stated, at the January meeting, that the Kew photographs are now taken by Miss Beckly, the daughter of the mechanical assistant of Kew; and it seems to be a work peculiarly fitting to a lady. During the day she watches for opportunities for photographing the Sun with that patience for which the sex is distinguished, and she never lets an opportunity escape her. It is extraordinary that even on very cloudy days, between gaps of cloud, when it would be imagined that it was almost impossible to get a photograph, yet there is always a record at Kew.

Mr. De la Rue remarked that all these investigations on the solar spots occupy a considerable time, and that the results may be interpreted differently by different persons. All that we have to do is to record faithfully the result of our observations; and it is hoped the Kew photo-heliograph will conduce very much to the advance of solar physics. Some time ago some experiments were made by the speaker, in taking solar spots on a very large scale, the pictures of the Sun's disk being on a scale of 3 feet for the Sun's diameter. There are certain difficulties in taking those pictures by means of a reflector; but Mr. Cooke has recently undertaken the construction of a 13-inch refractor, which it is intended to apply to solar and lunar photography.

On the 9th February, the forty-fifth annual general meeting of the Astronomical Society took place, and the report of the council was read by the President, Warren De la Rue, F.R.S. Before commencing, he announced the gratifying fact that although the medal awarded to Professor Bond, of the United States, did not reach that country till after his lamented death, yet he was some time before his decease made aware of the honour that had been conferred upon him, and of the grounds on which the award had been made.

After the usual obituary notices of deceased Fellows, the President gave an account of the proceedings of various observatories, and then touched upon the progress made in different branches of astronomical science during the past year.

Among the most remarkable of modern astronomical discoveries, and, until a year ago, certainly among the most unexpected accessions to our knowledge, is that which has come to us latest in the order of discovery. We refer to Mr. Huggins's observations on the spectrum analysis of the light from a comet. The light of the nucleus of Comet I. 1866, as examined under his instrument, gives a spectrum consisting of but one bright line, whereas the spectrum formed by the light from the coma gives a spectrum which is continuous. The inevitable conclusion to be drawn from these observations is opposite to that which our prepossessions would have led us to expect, inasmuch as, consistently with the present state of our physical knowledge, we are forced to conclude that the light of the cometary nucleus examined by Mr. Huggins must have emanated from a gaseous source; whereas, guided partly by other physical considerations, no doubt remains that the coma contains fluid or solid materials. Thus the suspicion of analogy between cometic and nebular matter has received this further confirmation. No doubt difficult observations of this nature require repetition, but the known caution and experience of the observer invite our confidence.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

England.—Mr. Darwin, in an interesting paper "On the Phenomena of Motion and Sensitiveness in Climbing Plants," has shown that the unsupported, outstretched extremity of a hop or convolvulus continues to revolve in circles, ever widening as it grows, and has calculated the rate of revolution, which varies in different plants, increases or decreases with a rise or fall of temperature, is diminished by any disturbance such as jarring or moving the plant from place to place, and varies also with the age and the general health of the plant. Mr. D. also experimented on the sensitiveness of the petioles and internodes of such plants as the clematis, &c., which climb by their leaf-stalks. Some of the experiments were very delicate. "A loop of thread," says Mr. D., "weighing a quarter of a grain, caused the petiole to bend; a loop weighing $\frac{1}{8}$th of a grain sometimes acted, and sometimes not. In one instance, the weight of even the $\frac{1}{16}$th of a grain, brought into continuous contact with the petiole, caused it to bend through nearly 90°." "Young internodes alone are sensible on all sides along their whole length." An internode, "rubbed six or seven times with a twig, became just perceptibly curved in one hour and fifteen minutes, and subsequently, in three hours, the curvature increased much; the internode became straight again in the course of the night." In numerous cases, particularly in *Solanum Jasminoides*, the clasping petioles increase in rigidity and thickness, the fibro-vascular bundles undergoing a change in their arrangement, so that from being originally semi-lunar on the cross-section, they develop into a close ring like that of an exogenous stem. Mr. Darwin thinks that both "leaf-climbers and tendril-bearers were primordially twiners; that is, are the descendants of plants having this power and habit." He regards plants which climb by tendrils as the highest type of climbing plants.

The following interesting and curious results were obtained from experiments on tendril-bearers. "A loop of soft thread, weighing $\frac{1}{32}$nd of a grain, placed most gently on the tip" of a tendril (*Passiflora gracilis*), "thrice plainly caused it to curve, as twice did a bent bit of platinum-wire, weighing $\frac{1}{50}$th of a grain; but this latter weight did not suffice to cause permanent curvature." After being touched with a twig, the tip of a tendril begins to bend in from 25 to 29 seconds. Transient irritation causes a tendril to coil into an open helix, but it soon straightens itself again, recovering its sensibility. If, however, left in permanent contact with the irritating object, the spiral coil continues. It is a remarkable fact that no curvature of the tendril results from the touch of other tendrils, or the impact of drops of rain, to which they appear to be habituated. Of Cucurbitaceous tendrils, next to *Sicyos* the most active are those of *Echinocystis lobata.* The internodes and tendrils of this plant revolve in about 1¾ hour; the former sweeping a circle or ellipse 2 or 3 inches in diameter, the latter often one of 15 or 16 inches in diameter. If a full-grown cucurbitaceous tendril fails to lay hold of an object, it soon ceases revolving, bends downward, coils up spirally, and ultimately withers and falls off; should it succeed in attaching itself, however, to a support, on the contrary, it thickens, hardens, and gains wonderfully in strength and durability. The contraction of tendrils into a spiral coil renders them highly elastic, and therefore in a gale of wind powerful organs of defence. Mr. Darwin says that the tendrils of *Bignonia capreolata* avoid the light, crawling into dark holes and crevices after the manner of roots. The tendrils of this plant will clasp a smooth pole, but soon detach themselves and straighten; a rough, fissured, and porous surface alone satisfies them, such as the bark of trees, to which they attach themselves. *Ampelopsis quinquefolia*, or the Virginia Creeper, also avoids the light, uniformly seeking dark crevices or broad flat surfaces, as a wall, a rock, or the trunk of a tree. The tips of the tendrils, brought into contact with such a surface, swell out, and form in a few days those well-known discs or cushions by which the plant firmly adheres to its support.

The learned and accomplished lichenologist, Dr. W. Nylander, has described, during the past year, 23 new species of British lichens; *viz.*, one new species of each of the following genera, Collema, Leptogium, Pyrenidium, Calicium, Lecanora, and Opegrapha, two new species of Pertusaria, five of Lecidea, and twelve of Verrucaria. Some of these lichens are so small, that they certainly required for their detection great nicety of botanical discrimination; as, for example, *Verrucaria tristicula*, Nyl., which was discovered by Admiral Jones on Moss (*Weissia*), in Aberdeenshire, and *Lecidea contristans*, Nyl., discovered by Isaac Carroll, Esq., on decaying Andreæ, on the summit of Ben Lawers.

Dr. Nylander has also described a collection of lichens made in New Zealand, in 1861, by Dr. Lindsay, including 26 genera and 117 species. Many of these lichens are common to Britain, Scandinavia, and the United States. We notice in the list seven species of Lecanora and Lecidea, three species of Opegrapha, two species of Sticta and Pertusaria, and one species of Arthonia, Platygrapha and Physcia, for the first time described by Dr. Nylander, and therefore new to science. Among the rarer and more interesting species in the collection, already described by other botanists, are Collema leucocarpium, Tayl., Bæomyces fungoides, Ach., Cladonia retepora, Flk., and Stictina fragillima, Bab.

Three new British flowering plants have been discovered.

Hedera Canariensis, described by Professor Babington,* "on old white-thorn trees, Phœnix Park, near Dublin;" *Rosa collina*, Jacq., discovered near Plymouth by Mr. T. R. A. Briggs; *Eurucastrum Pollichii* (*Eurucastrum inodorum*, Reichen.), collected by Mr. Joshua Clarke, near Saffron Walden, Essex.

Mr. F. E. Kitchener sends us a 'First List of Flowering Plants and Ferns found within Four Miles of the Close, Rugby.' Mr. K. publishes the list "incomplete, in the hope that additions will be sent." Botanists will be careful to mention the localities in which the plants are found, and their "earliest and latest dates of flowering." We would suggest to Mr. K., that the next list will be improved by avoiding the typographical errors which occur in this one, and by the substitution of the Botanical for the English names of the Families, as more appropriate and equally intelligible to the practical botanists, for whose use this list is printed.

Mr. J. Miers describes † 69 new species of *Cissampelos* (Menispermaceæ,) of which 46 belong to America, 11 to Africa, and 12 to Asia. The plants throughout the genus are diœcious, excepting in two or three instances where monœcious flowers occur; in one, the sexes are found in distinct racemes on the same plant, and in another the male and female flowers are on the same raceme (*androgynous*). Mr. M. denies that *Cissus Pareira* is the normal type from which these species are derived, and thinks that "nothing in the shape of sustainable evidence has been offered to prove" such a position. But supposing it to be true that all these species have thus originated, "if such modifications be now permanent, each confined within a limited range of distribution, and we can assign to them severally constant and determinable characters, then clearly, according to the rules of science, they ought to be considered distinct and valid species. In determining different kinds of plants, the practical botanist should not be guided by any theory of the distant origin of species, but should regard them in their present forms." There is some force in these remarks of Mr. Miers.

Mr. Isaac Seaman, M.R.C.V.S., says that sprouted grain is a superior nutritious cattle-food, and "an excellent substitute for the turnip and green rape of winter, and the different clovers and grasses of summer." Mr. Seaman affirms that, "during the past season, a very large number of lambs have been reared, thousands of sheep fattened, and upwards of twenty different flocks restored to health, by the use of semi-malted grain." That semi-malted grain should be a nutritious cattle-food is not at all unreasonable, and probably owing to the conversion of the starch of the grain into sugar, which, for both plants and animals, is more nutritious than starch, because more readily absorbed into the circulation.‡

* 'Journal of Botany,' December, 1865.
† 'Annals and Magazine of Natural History,' February, 1866.
‡ 'Veterinarian' for February, 1866.

The herbarium at Kew has recently acquired two very valuable private collections, Dr. Burchell's South African and South American collection, by gift from his sister, and the herbarium of Orchids of the late Dr. Lindley, by purchase. The latter contains upwards of 3,000 species, in perfect condition, fastened upon cartridge-paper and copiously illustrated with dissections and sketches by Dr. Lindley's own hand, and from other sources.

An international botanical congress is to be held in London on the 22nd and 25th of May, 1866. President, M. Alphonse de Candolle. The congress is restricted to two morning meetings. Two conversazioni and a banquet are announced to be held in the Guildhall, and to which the leading foreign visitors are invited as guests. Botanists desirous of reading a paper must forward MS. to Dr. Seeman, 57, Windsor Road, London, N., not later than the 31st of March.

The second part of the 'Genera Plantarum,' by Dr. Hooker and G. Bentham, F. L. S., &c., is published. It contains the Leguminosæ, Rosaceæ, Saxifragaceæ, Haloragaceæ, Rhizophoreæ, Combretaceæ, and Myrtaceæ. The recent illness of Dr. Hooker has delayed his revision of the Melastomaceæ, which may be expected next summer in the third part of the 'Genera Plantarum,' and this part will complete the Polypetalous orders and the first volume of 1,000 pages.

Sweden.—The Academy of Sciences at Stockholm is about to publish a *fac-simile* of a very interesting relic—a photo-lithographic copy of the first edition of the 'Systema Naturæ' of Linnæus, a folio of about fourteen leaves. Though very thin, it contains the groundwork of nearly all that the great Naturalist has accomplished.

America.—A catalogue of plants found in Oneida County, New York State, has been recently published by the authorities. This catalogue embraces the whole of the central part of the State of New York, and its author, Mr. John A. Paine, jun., has expended a great deal of labour in its preparation. Eighty-one native plants (species and varieties) are enumerated at the close, which are additions to the Flora and Catalogue of the plants of this State by Dr. Torrey. Twenty-five new plants are enumerated as naturalized. Professor Asa Gray says, "For a public document, this catalogue is well-printed, and as a hasty essay by an unpractised hand, it is creditable to its author, although there are many points which would not bear close criticism." *

At a recent meeting of the American Philosophical Society in Philadelphia, it was stated that the native plants of Pennsylvania were being rapidly displaced by the European flora. European

* 'Silliman's Journal,' January, 1866.

plants, formerly described as rare, were becoming plentiful. This change of the American flora was attributable to the spread of railway communication. Some of the botanists present thought that the foreign flora would supplant the native in a, comparatively speaking, very short period.

France.—In the 'Bulletin Générale de Thérapeutique,' Jan. 15, 1866, M. Stanislaus Martin describes a new medicinal plant called in Brazil *Jurubeba* (Solanum paniculatum), which is sold there commercially in the state of leaves, fruit, and roots. The plant is used in the form of emplastrum, syrup, wine, tincture, aqueous and alcoholic extract. It is chiefly employed in affections of the liver and spleen, in vesical catarrh, anæmia, chlorosis, and difficult menstruation. According to reliable testimony, this new drug promises to be the most powerful deobstruant yet met with.

Pumpkin-seeds are again in France popular with the profession as a remedy for tape-worm. M. Bouvier, in the 'Archives Médicales Belges,' relates his successful treatment of a little German boy five years of age, and Dr. Desnos reports two cases in the 'Journal de Chimie Médicale.' Dr. D. says that the results are still more favourable when the resinous extract of male fern (Aspidium filix-mas) is combined with the pumpkin-seed preparation.

At each session of the French Academy, January, 1866, M. Ad. Chatin read a botanical paper. In the first, "On the Tendrils of the Cucurbitaceæ," read January 2, 1866, M. Chatin states the facts as revealed by the microscopic examination of the anatomy of the tendrils, simple and branched, of the different genera of the order, and compares them with the microscopic anatomy of the other organs of the plant—*viz.* stem, leaf, petiole, peduncle, roots ordinary and adventitious, and deduces from them the following results:—1. The tendrils of the Cucurbitaceæ are of axile origin (either a branch or a peduncle). 2. If the tendril is simple, its homology is invariably with the axile organs; if, on the contrary, it is branched, its divisions correspond sometimes to the leaves and occasionally to the axile organs. 3. There is no relation of origin between the tendril and the ordinary roots; there is, however, a relation existing between the tendril and the adventitious roots. In his paper, read January 15, "On the Existence of a Third Membrane in Anthers," M. Chatin says, the opinion generally adopted amongst botanists is, that the valves of anthers are composed of two membranes, which were named by Purkinje *exothecium* and *endothecium*. But there exists always during a certain phase of the development of the anthers, a third membrane, more interior than the *endothecium*, which is the true *endothecium*. The endothecium of Purkinje should therefore now be denominated the *mesothecium*. The development of the cells of this third membrane and that of the pollen cells takes place together up to the period of the maturation of the pollen, when it disappears, having aided in the development of the pollen, no traces of it remaining except a granular matter on the superficies of the second membrane, or endothecium of Purkinje. Amongst other characteristics, this third membrane is distinguished by its colour, which is invariably the same as that of the pollen, which it nourishes and brings to maturity.

M. Chatin's third paper is "On the Localization of the Fibre-cells in some Anthers, and their Absence in others." The following is a *résumé* of the facts connected with this subject. The fibre-cells exist only upon given points of the anther valves, and are localized in connection with the following types:—*a*. The fibre-cells are disposed along the line of dehiscence (*Rhinanthus*). *b*. They are situated in the anthers longitudinally, or towards the line of detachment of the valves or connective (*Chlora*). *c*. They exist only at the extremities of the cells close to the pores of dehiscence (*Solanum*). *d*. They are borne only by one of two valves (*Witheringia rubra*). *e*. They are localized upon the uplifted valves (*Laurus*). *f*. They extend beyond the valvules (*Berberis*). *g*. They are scattered and with incomplete threads (*Orchis mascula*). M. Chatin thus sums up the result of his investigations in reference to the absence of the fibre-cells from anthers:—*a*. Anthers dehiscing by terminal pores are deprived of fibre-cells. *b*. Fibre-cells are defective in a certain number of anthers, having longitudinal dehiscence. *c*. In plants whose stamens are suddenly arrested in their development, whether morphologic or histologic, the absence of the fibre-cells coincides with the incomplete evolution of the pollen.

In his paper "On the Placentoid, a New Organ in Anthers," read before the Academy on the 29th of January, M. Chatin says that the function of this organ—which is so called from its analogy with the placenta of the ovule in the ovarian cell—is to nourish the pollen. It appears at the same epoch as the pollen, follows it in its development, and disappears when the pollen is mature. The Placentoid is absent from the Monocotyledons; it is wanting in the Monochlamydeæ and Thalamiflora, and M. Chatin would also add Calyciflora, if he had not observed it in *Cassia Marilandica*. He thinks that the presence of the Placentoid in the Corolliflora settles the long-controverted question as to the precedence of the Dicotyledonous classes and proves that Gamopetalous exogenous plants are more highly organized than Dialypetalous exogens, and that among these, the families with the ovary united to the calyx should rank above those with the ovary free, that is to say, above the corolliflora.

All botanists have noticed that a deposit of carbonate of lime forms on the leaves of Chara, Hippuris, and other submerged aquatics. MM. Cloez and Gratiolet supposed that this deposit was formed at the moment when the leaf absorbed from the water the carbonic acid which held the lime in solution. In a paper entitled "Chemical Researches on Vegetation, Functions of Leaves," read before the French Academy on the 12th of February, M. Corenwinder says that he repeated the experiments of Ingenhousz on the leaves of aerial plants—that is to say, he exposed them to the sun in bell-glasses, filled with water from a spring, which held bicarbonate of lime in solution, and found that the leaves became covered with a deposit of pure carbonate of lime. M. Corenwinder has thus verified the fact which M. Gratiolet only suspected. In the same paper M. Corenwinder says that leaves coloured wholly or in part, white, yellow, or red, in consequence of exhaustion, must be distinguished from those leaves which are normally these colours when their vitality is in all its plenitude; that the former do not produce oxygen under the influence of the solar rays, whilst the latter give it forth in abundance. Buds and leaves just issuing from them give off carbonic acid even in sunlight, which, however, decreases as they develop themselves, the amount of oxygen continually increasing until the leaves are adult and complete, when oxygen only is given off during the day. But if a plant is placed at a distance from a window in an apartment, or in a shady place, it gives off carbonic acid during the day, which varies in amount according to the nature of the plant and the feebleness of the light. This explains the difficulty experienced in preserving plants in an apartment.

IV. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

A question of as much interest to Chemistry as to Meteorology has recently been discussed at the Academy of Sciences. It relates to the presence of ozone in the atmosphere; and it elicited the opinion of some of the most eminent French chemists that none of the tests in ordinary use can afford satisfactory evidence on the question. It was shown, indeed, by M. Frémy, that Schönbein's paper is affected by many bodies likely to be present in the air; by the oxides of nitrogen, by peroxide of hydrogen, by the acid products of combustion, and by many other bodies, whose presence is not improbable. Further than this, the instability of ozone in the presence of organic matters and nitrogen, would lead to the conclusion that it must be destroyed as soon as formed in the atmosphere. The one test which will prove conclusively the existence of ozone in the air, M. Frémy said he had tried many times without obtaining the faintest indications of its presence. As the question is of great interest, we state that the test on which M. Frémy relies, is the oxidation of silver by a current of moist air. With regard to one body which is likely to be present in the air, and which would equally affect the iodide of potassium paper, *viz.* peroxide of hydrogen, we may state, that M. Houzeau has just announced* that he has proved its presence in water condensed from moist air.

While on this subject we may notice the statement of M. Jean, that carbonic acid under the influence of the electric spark splits up into carbonic oxide and oxygen, which latter is strongly ozonized.

The persistent white vapours obtained by the slow combustion of phosphorus in the air, and supposed by Meissner and others to be antozone, has been shown by Ozann to consist of nitrite of ammonia, thus confirming a statement to the same effect already published by Schönbein.

M. Soret has carried on some researches to ascertain the density of ozone, which he considers he has established to be one-and-a-half times that of oxygen, *viz.* 1·658. A consideration of the volumetric relations of ozone and oxygen would lead to the same conclusion, which the author above named considers he has proved by experiment.†

One unpleasant but important duty of a scientific chronicler is often to contradict things he has published before as facts. In our last volume (p. 278), we quoted the statement of MM. Moutier and Dietzenbacher, that by melting sulphur with small quantities of iodine, paraffine, and many other substances, they had converted it into a permanently soft and plastic mass. We have now the assertion of M. Keller,‡ that after repeating all the experiments of the above-named authors, he has never succeeded in producing a plastic mass unless the melted sulphur was poured into cold water, in which case, as is well known, sulphur is always rendered plastic for a time.

A paper by Dr. Wetherill, "On the Allotropic Modifications of Sulphur,"§ may be consulted by those who take an interest in this curious subject.

Professor W. H. Miller has been engaged in determining the crystalline forms of the graphitoidal varieties of boron and silicon. The latter he has ascertained to crystallize in octohedrons, while the crystals of graphitoidal boron appear to belong to the oblique system.

A discovery made by M. St. Claire Deville is likely to have important technical results. The magnesia obtained by calcining the chloride or nitrate of magnesium, when exposed to water, becomes converted into a compact crystallized hydrate of great

* 'Comptes Rendus,' Feb. 26, p. 430.
† Ibid., Nov. 27, 1865.
‡ 'Bulletin de la Société Chimique,' Nov., 1865.
§ See 'Chemical News,' vol. xiii., pp. 89, 97.

durability. A mixture of the same magnesia with chalk or powdered marble made into a plastic mass, and placed in water, soon becomes extremely hard; and M. Deville hopes in this way to get a modelled bust converted into artificial marble.

Dolomite calcined at a low red heat and powdered, and then made into a paste, forms under water a stone of extraordinary hardness.

It has long been known that calcined magnesian limestone forms a very strong hydraulic cement; and Dr. C. Calvert has shown that the strength of the cement is in direct proportion to the amount of magnesia. Dr. Calvert also confirms the statement of M. Deville, that the calcination of magnesian stones must be carefully managed, too high a temperature completely destroying the hydraulicity of the material. It seems important also that the calcined product should be very finely ground to improve the setting.

Harrogate water has long enjoyed some celebrity as a remedial agent, but the recent analysis of one spring by Dr. Sheridan Muspratt* is likely to bring it into still greater repute. The eminent chemist above named has discovered in what is known as the "Cheltenham spring," a large proportion of *protochloride of iron*, as much indeed as 16·011 grains in the imperial gallon. This, therefore, is the strongest chalybeate spring known, and as the condition in which the iron exists is one of the most favourable for its assimilation by the animal economy, the water is likely to prove most efficacious in all those affections, too numerous to mention, for which iron is prescribed. It deserves mention that chloride of barium is also present in the water in unusually large quantity, but this will not detract from the medicinal value of the spring.

Passing to the mention of other mineral elements, we find an easy method of accomplishing what has hitherto been found a difficult object. It is a process by M. Terreil, for separating cobalt and nickel in minute quantities. To a solution containing the two metals together with manganese, the author adds ammonia, until the precipitate first formed is redissolved. He then makes the solution hot, and adds a solution of permanganate of potassium until the mixture acquires a permanent violet colour. After this the solution is boiled for a few minutes with a slight excess of hydrochloric acid, and after having been kept hot for some time, it is set aside for twenty-four hours. At the end of this time the cobalt is deposited as roseo-cobaltic hydrochlorate, 100 parts of which contain 22·71 of cobalt. To separate the nickel in the residual liquor, the manganese is precipitated by first saturating the liquor with ammonia, and then adding an alkaline hypochlorite. This throws down all the manganese, and the nickel remains in the solution, from which it

* 'Chemical News,' vol. xiii., p. 26.

may be separated by sulphuretted hydrogen. The full details of this process will be found in the place indicated below.*

On organic chemistry an immense number of papers, for the most part of a theoretical character, have been published. Our space allows us only to mention a few of a practical and generally interesting nature. We must, however, first advert to one most important discovery, which illustrates the practical aim of the studies of our most advanced chemists. It is the production of *Phenose,* a body possessing all the chemical characteristics of sugar, by Carius, from benzole. The steps by which this wonderful transformation was effected could only be made intelligible by a long description, and we must content ourselves with the bare mention of the fact, referring the reader interested to the original paper.†

A useful test for discriminating between glucose and cane sugar has been discovered by Nicklés, who finds that the latter when heated with bichloride of carbon in a sealed tube becomes black, while the former (glucose) remains of its original colour.

Another test for glucose is given by Braun,‡ who heats the glucose with some solution of caustic soda, then adds a few drops of a solution of picric acid, and boils. A solution containing much glucose now changes to a deep blood-red colour, weaker solutions showing lighter shades of red. Cane sugar does not produce the same effect. The above test is recommended to physicians for detecting sugar in urine.

A new process for the production of an aniline black has been devised by M. Paraf, which however is open to the objections stated below. The process is said by the inventor to produce a black without the intervention of a metallic salt, and is as follows:—Hydrochlorate of aniline is dissolved in a solution of hydrofluosilicic acid, and chlorate of potassium is either added to the mixture, or the mixture properly thickened is printed on cloth prepared with chlorate of potassium. Upon heating the printed cloth to 90° or 95° F., a beautiful black colour is said to be produced. M. Lauth, however, states § that the black colour is caused by copper derived either from the vessel in which the mixture is prepared, or the roller with which it is printed. He states that when the solutions are prepared in porcelain or glass vessels, and the mixture printed by hand with a wooden block, only a dull grey colour is obtained.

M. Berthelot continues his important researches on acetylene, showing now its invariable production when hydrocarbons and hydrocarbonated bodies are submitted to incomplete combustion.‖ The experiment may easily be made in a test-tube with marsh gas

* 'Comptes Rendus,' for Jan. 15, 1866.
† 'Annalen der Chemie und Pharmacie,' December, 1865.
‡ 'Zeitsch. für Analyt. Chemie,' vol. iv., p. 187.
§ 'Bulletin de la Société Chimique,' Feb., 1866.
‖ 'Comptes Rendus,' vol. lxii., p. 94.

or a few drops of ether. The tube being filled with the gas or the vapour of ether, and a few drops of ammoniacal cuprous chloride added, the gas is ignited and the tube rolled about so as to bring the products of combustion in contact with the re-agent. The characteristic red precipitate of acetylide of copper will be produced wherever the flame touches the copper solution. The incomplete combustion of coal gas produces a notable amount of acetylene, recognizable by its peculiar odour as well as the chemical test.

Based on the production of acetylene from hydrocarbons, M. Berthelot has suggested a new method of detecting them in mixed gases.* If, for example, a mixture of carbonic oxide and hydrogen or of hydrogen and marsh gas, or any hydrocarbon vapour, be submitted to the action of the electric spark for a few minutes, acetylene will be produced in the latter mixture, but not in the former.

Lastly, M. Berthelot shows that the compounds which acetylene forms with metals offer examples of a new series of compound metallic radicals.† He describes at length those containing copper and silver, with some of their salts.

As a point of some technical interest, we may mention that M. Perret has discovered a process by which the first step in the preparation of citric acid may be taken where the lemons grow, and thus save the exportation of the fruit or juice. He first precipitates the acid with magnesia, so forming the tribasic citrate; this he afterwards boils with another portion of juice, by which he forms a bibasic citrate, an easily crystallizable and permanent salt, convenient to transport for the subsequent manufacture of citric acid.‡

In conclusion, we may mention that, after an elaborate investigation, Fresenius has shown that a mixture of air and carbonic acid, or either alone, is only completely deprived of moisture by passing over phosphoric anhydride.§

Proceedings of the Chemical Society.

At the meeting held on December 7, 1865, Dr. Gladstone communicated some Notes on Pyrophosphodiamic Acid, and Dr. Hugo Müller described Phenylo-phosphoric Acid and some of its salts.

The next meeting, December 21, was occupied with a paper by Mr. James Yates, "On the best Material for Mural Standards of Length." To extend knowledge of the metric system, it has been proposed to the British Association to set up standards on the outside walls of public buildings, and Mr. Yates's object in intro-

* 'Bulletin de la Société Chimique,' Feb., 1866.
† 'Comptes Rendus,' vol. lxii., p. 455.
‡ 'Bulletin de la Société Chimique,' Jan., 1866.
§ 'Zeitschrift für Analyt. Chemie,' vol. iv., p. 177.

ducing the subject at the Chemical Society was to obtain the opinion of chemists as to the most permanent material of which to construct the standards. He was himself in favour of bars of brass coated with gold or platinum, or speculum metal improved by the addition of a little arsenic. The general opinion of the meeting was perhaps in favour of graduated porcelain scales, such as used by Mr. Casella for barometers and thermometers, and upon which, as Dr. Frankland stated, the weather could have no influence. White glass, with a coloured surface which could be ground away to show the divisions of the scale, was also suggested.

On January 18, Dr. Gladstone read a paper on Pyrophosphotriamic Acid, and Dr. Wanklyn gave an account of his recent researches on the action of Carbonic Oxi le on Sodium Ethyl. Dr. Debus afterwards made some remarks on the constitution of Glyoxylic Acid.

On February 1, Dr. Gilbert gave a lecture "On the Composition, Value, and Utilization of Town Sewage." In the course of his lecture he gave a rapid review of the whole subject; but we must content ourselves with placing before our readers the following propositions with which the lecture was concluded:—1. It is only by the liberal use of water that the refuse matters of large populations can be removed from their dwellings without nuisance and injury to health. 2. That the discharge of town sewage into rivers renders them unfit as a water-supply to other towns, is destructive to fish, causes deposits which injure the channel, and emanations which are injurious to health, and is also a great waste of manurial matter. 3. That the proper mode of both purifying and utilizing sewage-water is to apply it to land. 4. That, considering the great dilution, constant daily supply, greater amount in wet weather, and cost of distribution, it is best fitted for application to grass, although it may be occasionally applied to other crops under favourable circumstances. 5. That the direct result of the general application of town sewage to grass land would be an enormous increase in the production of milk (butter and cheese) and meat, whilst by the consumption of the grass a large amount of solid manure, applicable to arable land and crops generally, would be produced. 6. That the cost or profit to a town of arrangements for the removal or utilization of its sewage must vary very greatly according to its position and to the character of the land to be irrigated. Under favourable circumstances, the town may realize a profit, but under contrary conditions it may have to submit to a pecuniary loss to secure the necessary sanitary advantages.

On February 15, Mr. G. T. Chapman read a paper "On the Action of Nitrous Acid on Naphthylanine." A paper by Mr. G. Davies was also read "On the Action of Heat on Ferric Hydrate in presence of Water," in which the author proved that water is expelled from ferric hydrate by long boiling in contact with water. The author draws the conclusion that the natural beds of ferric oxide ore may have been deposited from aqueous solution, and become subsequently dehydrated by long exposure to a moderate heat.

The next paper read was by Professor Kolbe, "On the Prognosis of Alcohols and Aldehydes." It was of a purely theoretical character.

V. ENTOMOLOGY.

(*Including the Proceedings of the Entomological Society.*)

It is not often that entomological science is enriched with such works as the one recently published by Mr. T. Vernon Wollaston, entitled, 'Coleoptera Atlantidum; being an Enumeration of the Coleopterous Insects of the Madeiras, Salvages, and Canaries.' Since 1847, Mr. Wollaston has made several prolonged visits to one or another of those islands, and in this volume he brings together all that has yet been registered on the subject. His introductory remarks, extending to over forty closely printed pages, are well worthy the attention of all philosophic naturalists, and we can only regret that our space will not allow us to give more than a summary of two or three of them. Of the whole number of genera (423), including 1,449 species, not one is found characteristic of the true African region, but so many of these are endemic that Mr. Wollaston thinks we should hardly be warranted in referring them to the European fauna. The author inclines to the opinion that these islands were aboriginally stocked while yet a part of a continuous land, and that the numerous slight modifications or insular states "which now present themselves, have not been matured by any process of slow development," but were brought about at a very remote period, probably "when this great Atlantic province was rent asunder." Space will not allow us to enter on the author's arguments in support of this hypothesis; but we cannot avoid calling attention to the "marvellous types" characteristic of the Euphorbian fauna. In the Canaries especially, where whole tracts are covered with Euphorbias, not less than fifty species of Coleopterous parasites are *exclusively* confined to them, not indeed to the living, but to the dead plants, and are met with in such incredible numbers that "the rotten stalks and branches seem absolutely alive with them."

In a former number of this Journal (ii. p. 669), when giving an account of the discovery by Professor Wagner, of Kasan, of the "larvæ-producing larvæ" of the *Miastor metraloas*, we spoke of them as having seemed to him to have been developed from "embryonal bodies" belonging to the organism of the parent larvæ.

M. Ganine, of Karkow, has since, however, denied this statement, and describes the reproductive organs as two little sacs placed in the eleventh segment of the body, and in which the germs, or pseudo-ova, are developed. This account has been substantially confirmed by Dr. Leuckhart and M. Pagenstecher.

Dr. Asa Fitch, in his 'Reports,' &c., states that a new enemy to the bee has appeared in the Nebraska territory, and so great has been the destruction caused by it, that no swarm had been thrown off during the season, or at least up to the time of the Report. The insect in question—*Trypanæa apivora*—is a fly belonging to the family of Asilidæ, some of which are known in Europe to attack bees, wasps, and even insects so formidable and apparently so well protected as the tiger-beetles (*Cicindelæ*).

A work by M. A. Edouard Pictet, entitled 'Synopsis des Néuroptères d'Espagne,' has just been published at Paris and Geneva. It is, we believe, the first production of one who has hereditary claims to our attention had he no others, which, however, is far from being the case. The plates—fourteen in number—by the well-known artist Nicolet, are printed in tinted ink suitable to each insect figured, and coloured by hand. Only in this way could the delicate gauze-like wings of these marvellously exquisite creatures be portrayed, and this has been done with a success that may be almost pronounced perfect. The Libellulidæ are retained among the Neuroptera.

Entomological Society.

At the December meeting, the Secretary exhibited a general collection of insects made by Lieut. Bevan at Moulmein, and in the valley of the Solween. It was mostly composed of Indian and not Malay types. Mr. F. Smith exhibited numerous specimens of a moth used for food by the natives of New South Wales, and named by them "Bugong" (*Agrotis spini*, Guén.). It is found in large numbers in November and December, when their bodies are in a very oleaginous state. A beautiful series of engravings of the insects of the United States, together with their transformations, as far as they are known, made by Mr. Glover, of Washington, was exhibited by Mr. Moore. The Rev. Joseph Greene exhibited a series of *Acidalia subsericeata* and *A. mancuniata*, some of which appeared to throw a doubt on the claims of the latter to the specific distinction which it has been quite recently supposed to possess. Professor Westwood read descriptions of new species of *Cantharocnemis*, including two new genera or sub-genera? Mr. MacLachlan read a paper on varieties of *Sterrha sacraria*, with notes on the variation of species in the Lepidoptera. Mr. Semper (of Altona) sent drawings and a description of a remarkably fine new species of *Papilio* from the Samoa Islands.

January.—Mr. Stevens exhibited a collection of insects from the Himalayas, mostly Lepidoptera. Extracts of a letter from Prof. Snellen von Vollenhofen were read by Prof. Westwood. The writer stated that *Chareas granimis* and *Heliophobus popularis* had appeared in immense numbers in certain districts in Holland, and had proved very destructive. Mr. Bates gave the meeting some account of the proceedings of Mr. E. Bartlett, who had recently gone to the Amazons on a zoological excursion, and had already made his way up the Ucalayi, which may be considered the upper part of the main river, to nearly the latitude of Lima. Mr. Hewitson sent a paper containing descriptions of new species of Hesperidæ. The President (Mr. Pascoe) communicated a list of the Longicornia collected by the late Mr. Bouchard at Santa Martha. Of fifty-three species nearly half were new to science.

The anniversary meeting was held January 22. After the usual report of the proceedings and position of the Society had been made, and in which it was stated that fifty-nine new members had been elected since the previous anniversary, the President read his address, reviewing the progress of entomology during the past year; after which it was announced that Sir John Lubbock, Bart., F.R.S., &c., had been elected President; J. W. Dunning, M.A., &c., Secretary; and S. Stevens, F.L.S., &c., Treasurer.

February.—At the previous meeting it had been announced that one of the prizes offered by the Council for the best essay on economic entomology had been adjudged to Dr. A. Wallace, of Colchester, for his essay on Ailanthiculture. In now presenting it to the author, the President stated that the Council had decided upon again offering two prizes of five guineas each for essays of sufficient merit on any subject connected with the habits, anatomy, or economy of any insect or group of insects serviceable or obnoxious to mankind, the essays to be sent to the Secretary on or before the 30th November, 1866. Mr. S. Stevens exhibited a male of the rare *Papilio Semperi*, a butterfly with black wings and a bright scarlet body. Mr. W. Wilson Saunders brought for exhibition a numerous suite of *Heliconia Melpomene*, all taken at Cayenne, showing the excessive variation of colour to which the species was subject, and, consequently, how little reliance ought to be placed on *mere* colour alone in the discrimination of species, at least in that portion of the diurnal Lepidoptera. It is to be hoped that those Lepidopterists who are constantly favouring us with descriptions of "new species," which in many cases appear to depend on very slight differences of colour, will not be forgetful of its uncertainty as a specific character. Professor Westwood and Mr. MacLachlan called attention to remarkable gynandromorphous examples, the former of *Dytiscus latissimus*, the latter of *Argynnis paphia*. Mr. Hewitson communicated a paper describing seventeen new species of Hesperia.

VI. GEOGRAPHY.

(Including the Proceedings of the Royal Geographical Society.)

The death of Dr. Barth, to which we just alluded in our last number, will leave a void not easy to be filled. At the age of twenty-five, the young traveller had explored the southern coasts of the Mediterranean. He subsequently traversed Algiers, Tunis, Tripoli, and Benghazi, whence he was on his road to Cairo, when he was beset by robbers, plundered and wounded. He continued his journey, however, and visited Egypt, Syria, Palestine, Asia Minor, and Greece. His next expedition was into the interior of Africa, across the Sahara. About this journey he wrote a valuable work, which much extended his fame.

Another African traveller, Baron von der Decken, the recipient of one of the gold medals of the Royal Geographical Society, although it does not appear that he has lost, has run the risk of his life, and been exposed to great peril in his expedition from the Zanzibar coast up the river Juba. Separated from his party, through going in search of assistance in getting one of his steamers off certain rocks, he seems to have fallen into the hands of a Somāli chief. All who have resided on the Zanzibar coast, and have any knowledge of the interior, unite in declaring their conviction that the Baron will only be detained in order to secure a heavy ransom, and that his life is not in danger.* A fuller account of his position will be found further on.

The most active proceedings in the way of geographical research of which we have advices, are those of the Royal Engineers under Captain Wilson and Lieutenant Anderson in the Holy Land. A sum of 2,000*l*. has been assigned for this undertaking, which is to be carried on until April, after which the heat will not admit of further research. The route marked out for the intermediate period begins at Beyrout, and passes by way of Damascus to the source of the Jordan, continues the descent of that river, exploring various sites on the Lake of Gennesaret, and the lower valley of the Jordan, including Shiloh, Jezreel, Samaria, Bethel, and ending with the neighbourhood of Jerusalem. This expedition is intended to be preparatory for others in subsequent years, should money come in. The party have traversed as far as the centre of the western side of the Lake of Tiberias. Numerous astronomical observations have been recorded, and localities fixed; thus maps may become more trustworthy. Photographs have been taken of various important architectural remains; whilst plans, sketches, and drawings have been made of buildings, tombs, architectural ornaments, &c. In

* We have seen the report of his death since the above was written, whether it is trustworthy or not we cannot say.

many cases ruins have been excavated, and thus disputed points of topography have been settled. Inscriptions have been copied, or brought bodily away; and thus we may look forward to a flood of light being thrown upon many matters about which we are at present completely in the dark. Jewish, Phœnician, Assyrian, and Syrian antiquities will probably all receive some assistance from this expedition.

It is not alone in new, unknown, or even forgotten countries that geographical knowledge may be advanced. In almost the oldest of known countries we are acquiring information, as the last paragraph shows; in the most highly-civilized country of modern Europe something remains to be done. A M. Bourdaloue has brought before the Société de Géographie the importance and necessity of a general survey of France similar to our trigonometrical survey of Great Britain. The advantage of a work of this kind can hardly be exaggerated. For all matters of drainage, irrigation, and sanitary arrangements, it affords facilities, and it is indispensable for plans of extensive public benefit.

Whilst the Germans are preparing an expedition to the North Pole, to start next spring, towards which project the Prussian Government contributes a corvette of 200 horse-power and 9,000*l.*, a voice comes to us from the deep mists of the northern winter, speaking in mysterious sounds of some of the lost navigators of former expeditions. Captain F. C. Hall, who has already written a book about the habits of the Esquimaux from observations he made during an expedition in search of Sir John Franklin, writes word that in a second journey he has been told by those people, on whom he seems to rely more than northern travellers usually do, of the existence of Captain Crozier and two seamen. Very detailed and circumstantial stories of the loss of the ships, the destruction of others of their company, and the discovery of these men and of another who has since perished by disease, were given to the enthusiastic captain; but it does seem remarkable that, should they still be alive, they have never found means of communicating with any of the numerous parties that have travelled over their route, nor have been enabled to get within reach of any of the northern outposts of the Hudson's Bay Company. Until something more trustworthy is reported, it seems scarcely worth while pursuing such fleeting shadows as the Crozhar, Parme, and Pezart (Fisher) of the Esquimaux squaw.

We have already spoken of the German travellers in Africa, of the German expedition to the Pole, it remains to mention two important German works of Geography lately published: 'Journeys on the Upper Nile,' from the papers of W. von Harnier, with a Preface by Dr. Petermann, chiefly referring to the countries between Khartûm and Zanzibar; and Dr. Adolph Bartien's 'Peoples of

Eastern Asia—Studies and Journeys.' Besides these contributions to science, the Austrian Government is fitting out an East Asiatic expedition, making a very fair proportion of work from the German Fatherland.

Proceedings of the Royal Geographical Society.

At the fourth meeting of the Royal Geographical Society, M. P. B. Du Chaillu gave an account of his second expedition to Western Equatorial Africa. We have from time to time chronicled the proceedings of this traveller, but we will here give again a résumé of his doings. Leaving London on the 5th of August, 1863, he arrived the same autumn at the mouth of the Fernand Vaz River, where, owing to his having to land in a canoe, he lost all his scientific instruments, and was consequently compelled to wait a year for the arrival of new ones. In the meantime he made collections of objects of botanical and zoological interest, which were forwarded to England. On the arrival of fresh instruments he journeyed eastwards over a belt of flat country, and then gradually ascending ridges of hills, mostly covered with dense forests, and rising to the height of about 2,400 feet. He traversed the country of Ashira, Apinji, and Otondo, and was at last driven back by the natives, who attacked his cowardly men, because one of them had accidentally (?) shot two natives. His most remarkable discovery on this occasion was that of a race of dwarfs, some of whom appear to have been not more than four feet and a-half high. They were a nomadic, plundering race, something like our gipsies in their habits, and distinguished by short tufted hair. This account is astonishing enough, but we can only take what stories the traveller likes to tell us. In the disgraceful flight of his attendants, M. Du Chaillu lost his natural history collections and photographs, but succeeded in saving his chronometers, journals, and one set of very valuable astronomical observations.

M. Du Chaillu's veracity was warmly defended by Professor Owen, especially in reference to the gorilla, and a fish-eating, otter-like quadruped, the Potomogale velox, which latter animal had been classed by others as a rodent, but, as it turned out, without foundation. Mr. J. Crawfurd impugned the account of the dwarfs, but the traveller reiterated his assertion, and mentioned that he was able to examine only one or two specimens.

The next meeting was devoted to the discussion of subjects connected with Australia. The society had voted a sum of 200*l.* towards the expenses of the expedition in search of the relics of Leichhardt's party. This undertaking was commanded by Mr. Duncan McIntyre, who has already explored a route from Victoria to the Gulf of Carpentaria in the search for pastoral lands. The explorations will be continued as long as means are forthcoming. The governments of Victoria, South Australia, and Queensland have given large grants of money, and subscriptions are asked in this country.

The locality of the last new settlement at Cape York, at the extreme north of Australia, was described in a paper by Mr. John Jardine, a police magistrate. The district is a peninsula of fifteen miles in length, almost divided from the mainland by the Kennedy River. The soil is fertile: a reddish loam with sand and blocks of sandstone. Horses, cattle, pigs, and goats flourish, but the climate is unfit for sheep. The rainy season lasts for four months during the hottest part of the year, the thermometer reaching 98° in the shade. During the rest of the year, from April to November, a S.W. wind blows a fresh breeze, and the heat averages from 80° to 85°. The climate is perfectly healthy, and the colony might become a sanatorium for invalids from China and India. Four tribes of aborigines inhabit the district.

Across the continent at its north-western corner lies the River Glenelg, discovered by Sir George (then Captain) Grey and Lieutenant Lushington in 1838. The mouth of this stream had never been determined until the expedition in which Mr. James Martin, M.B., took a part, and of which he gave an account in a paper before the society. The *débouchement* takes place into Doubtful Bay, from which the way leads by a difficult passage into George Water, a large expanse, into which numerous channels landward seem to run; but they all ended in a tangled mass of mangroves. After a search of six days the true channel of the river was found at the north-eastern end of the George Water. The party passed thence upward, through a rugged hilly country, which afterwards became more level. The extraordinary fall of the tide (28 feet) makes the navigation very difficult. The country is fertile, but unsuited for sheep.

The misfortunes of Baron von der Decken's expedition on the Juba River, in the east of Africa, engaged the attention of the society at its next meeting, to the exclusion of the paper on the exploration of the River Purûs, which was postponed to the next meeting. The Hanseatic Consul at Zanzibar reports that the Baron made seven months' preparation on that coast, and then commenced ascending the Juba River with two steamers, one of which was wrecked soon after the starting of the expedition. About a month after, the Baron arrived at Berdera, where some disagreement with a Somāli chief arose, which was afterwards settled. A few miles farther up the second vessel struck on some rocks and began to fill. The cargo was taken out and the Baron and Dr. Lusk returned to fetch assistance from Berdera. Three days later some natives from the last-mentioned town attacked the party encamped by the river and killed two; the remainder embarked at the command of Baron von Schickh, the leader of the party in the camp, and descended the river with all speed in the injured vessel, leaving the Baron in the power of the Somāli chief. The former and present British Consuls at Zanzibar express their opinion that the Baron von der Decken is retained at Berdera only with a view to obtain a heavy ransom, and that he runs no risk of his life. The commander of the British squadron has received commands from the Admiralty to render all the assistance in his power towards aiding this British expedition. Baron von der Decken had intended to cross the unknown parts of eastern Africa, and to strike the Eastern head waters of the Nile.

After Africa and Australia, South America seems to offer the best field for ambitious geographers. In this continent the huge river Amazons affords a means of communication with the extreme limits of the interior, and a means of communication that is soon likely to be opened to all the world; the exclusive privilege granted to a Brazilian Steam Navigation Company being about to be withdrawn. This great river could not of course penetrate all parts of the interior; but it has been hoped that its tributaries might supply the wants of the principal channel. With a view of making this means of transit available to the people immediately to the east of the Andes, Mr. W. Chandless, M.A., has attempted to explore the River Purûs, a tributary of the Amazons, that has previously baffled native traders. He was entirely successful in tracing this stream from the parent river to its source, and discovered that it was not, what he had hoped it might prove, in connection with the Peruvian river, Madre de Dios, but that it ended two degrees farther north. The banks are completely shut in by impenetrable forest, so that in no part was a view of the neighbouring country obtained by Mr. Chandless and his boat's crew of Bolivian Indians, and the inhabitants at the upper extremity proved to be small tribes, who had held no communication with the semi-civilization below, and were consequently in the Stone Age. The course of the river is very tortuous, but unobstructed by rapids, and flows for 1,866 miles. After the reading of the paper which described Mr. Chandless's discoveries, the opinion was expressed by Mr. Bates that a river so tortuous, whose mouth was at a distance of 1,100 miles from the Atlantic, with such a small population on its banks, could never be made available for commerce. On the main stream steamers ply 3,100 miles from its mouth.

VII. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

One of the most recent memoirs published by the Geological Survey of India is Dr. Ferdinand Stoliczka's descriptions of "Geological Sections across the Himalayan Mountains, from Wangtu Bridge on the River Sutlej to Sungdo on the Indus; with an Account of the Formations in Spiti, accompanied by a revision of all known Fossils from that District." The geology of India possesses an ever-increasing interest to all who care to inquire how far the structure of England is typical of that of far distant countries. Hitherto the progress of the Indian survey has been fertile in results showing the similarity of the formations in that country to those in Europe; it has also brought to light many highly interesting and curious points of difference, especially respecting the association of fossils, which in several cases has been shown to be very abnormal when measured by an English or even a European standard. The memoir now before us treats of the geological structure of the districts of Spiti and Rupshu, the latter being about 50 miles to the north of the former. The geographical position of these districts will be understood when we say that they lie about 100 miles north-east of Simla, and about 50 miles south-east of Ladak. The formations present in Spiti consist of a central Gneiss, Lower and Upper (?) Silurian, Carboniferous, Upper Trias, Lower and Middle Lias, Oolites of an uncertain horizon, Cretaceous strata with Rudistes, and fluviatile and lacustrine beds of recent date. In Rupshu occur Middle and Lower Lias, Rhætic, Triassic, and Carboniferous rocks, as well as certain Metamorphic schists and Gneiss, Epidote-, Diallage-, and Serpentine-rocks, and fluviatile and lacustrine deposits.

In giving a condensed notice of so extensive a memoir, we can only pretend to notice some few points of the greatest interest, and more especially the light thrown by Dr. Stoliczka on the question of the correlation of the strata on the northern and southern slopes of the Himalayas. The "Central Gneiss," as its name implies, seems to form the division between the two series of formations. It also appears that the metamorphic rocks of the southern slopes correspond in part with the Lower Silurian of the northern, the remaining strata of this division being also represented by similar rocks on the southern slope. The Upper (?) Silurian, Carboniferous, and Upper Triassic rocks appear to be equally represented on both sides; but, on the other hand, the Liassic, Oolitic, and Cretaceous strata of the northern slope are unrepresented on the southern, though they exist, at least partially, in the Punjab and farther to the south in Cutch. Another contrast is presented by the occurrence of strata on the southern side, apparently of the age of the Bunter sandstone, which seem to be altogether wanting on the northern. These differences indicate to a great extent the important conclusion to which Dr. Stoliczka has arrived respecting the relation existing between the orographical and geological features, namely, that not one of the geological zones is *essentially* connected with the geographical or orographical ranges. Whether it may ultimately be possible to trace any connection of this kind is a question of great practical and theoretical interest, and we cordially agree with Dr. Stoliczka's concluding Anglo-German exclamation, "Large is still the field for geologists in India!"

The origin of prairies has recently formed the subject of three papers in the 'American Journal of Science,' by Prof. Winchell, Mr. Lesquereux, and Dr. Dana, in the order mentioned. Prof. Winchell believes that the prairies are of lacustrine origin and of post-glacial date, that all seeds contained in these lacustrine deposits would perish, and that the vegetation which afterwards appeared "was more likely to be herbaceous than arboreal," because the seeds must have been brought from distant regions. Mr. Lesquereux considers that the prairies were formed by a process of natural reclamation from the borders of lakes, mouths and banks of large rivers, and coasts of seas (freshwater and salt), and cites in illustration the cases of the Mississippi, Lake Michigan, &c. He thinks that the nature of the soil formed under these circumstances would be such as to favour only the growth of sedges and grasses; and he endeavours to show that his explanation will account for the existence of all known prairies and large flat tracts of land, including "the natural meadows of Holland," &c. Dr. Dana advances an explanation of a totally different nature, namely, that the absence of forests and presence of prairies are caused by the dryness of the climate, while conversely the presence of forests is caused by its moisture. Dr. Dana's facts are indisputable and generally received, for everyone acknowledges the intimate relation of the moisture of the climate to the existence of forests; the only question is, Which is the cause and which the effect? Experience has shown that the moisture of a climate may be increased by planting forests, and diminished by clearing them.

Dr. A. von Koenen has published descriptions of the Lower Oligocene fossils of Helmstädt, near Brunswick, in the last number (vol. xvii., part 3) of the 'Zeitschrift der deutschen geologischen Gesellschaft.' It appears that the author has found 122 species of Mollusca and six corals in that locality, making in all 128 species; of these 17 are peculiar to Helmstädt, and one (*Nautilus imperialis*) is but doubtfully determined. Of the remaining 110 species, 100 are known to occur in the Lower Oligocene strata of other localities, while only 31 have been found in true Upper Eocene beds, and nearly as many, namely 30 species, in Middle Eocene deposits. Of course Herr von Koenen, being a warm advocate of

Professor Beyrich's Oligocene division, makes use of this very marked result to urge the claim of the "Oligocene" to universal recognition as representing a period distinct from the Eocene. In a former chronicle * we have seen that Professor Reuss's investigations into the Foraminifera and Bryozoa do not support such a conclusion; but it is possible that this difference in the evidence yielded by these several classes of animals may be owing to the greater vertical range generally possessed by the more lowly organized animals. The practice of "counting heads" does not, however, find much favour amongst the more advanced palæontologists, and, as it seems to us, it can only be defended on the ground that, on a large scale, errors tend to neutralize one another. Dr. von Koenen has also omitted to reckon as Upper Eocene species those shells which have been found in Lower Oligocene and Middle Eocene deposits, and which therefore must have existed during the Upper Eocene period; that is, of course, unless the universally accepted principle that such is the case be false; if it be false, the *onus probandi* lies with him.

In the same number of the 'Zeitschrift' the late Dr. Oppel proposes the name "Tithonic Stage" for the strata known to us as Portland, Purbeck, and Wealden. This association under one name of the beds between the Neocomian and the Kimmeridge Clay will doubtless be useful in regions where the true freshwater Wealden and Purbeck beds do not exist; but it is very unlikely to be adopted in England.

M. Barrande continues to defend his "Colonies" with great vigour, and the third part of his 'Défense des Colonies' is a large volume in itself. In it he treats at great length of the two upper members of his "third fauna," being stages G and H; but the only point of general interest is the conclusion that the fauna of these strata is not more nearly related to that of the Devonian system than are the faunas of the higher zones of the Upper Silurian formation in other regions, while the connection of the lower stages of this "third fauna" with the Devonian system is closer than that of the higher divisions G and H. The question at issue between M. Barrande and his opponents is one of such complexity that we cannot attempt to discuss it; but it seems unfortunate that the term "colony" should be applied to a precursor of the main fauna, instead of to isolated branches given off by the parent.

The pages of the 'Reader' have for some time past been adorned by a desultory discussion on Mr. Croll's hypothesis, that the glacial submergence was a necessary result of the influence of the weight of the ice-sheet, which during the glacial period covered the northern parts of the globe, on the earth's centre of gravity. Mr. Croll assumes, for purposes of illustration, that the ice in Greenland

* 'Quarterly Journal of Science,' vol. i. p. 100.

and other Arctic regions during the glacial period was 7,000 feet thick, and that it gradually diminished in thickness towards the Equator. The specific gravity of the ice-sheet being taken to be to that of the earth as 1 to 7, this mass would "shift the centre of gravity of the earth 500 feet to the north of its former position, and as the ocean would accompany the centre, there would consequently be a submergence at the North Pole equal to 500 feet." Again, "At the time that the ice-sheet would be forming on the northern hemisphere, a sheet of equal size would be melting off the southern, and this of course would double the effect." This hypothesis is obviously based on the assumption which we have just given as the ultimate conclusion, and therefore rests on a most ingenious example of the fallacy popularly known as "arguing in a circle." Most of the geologists and physicists whose letters on the subject have appeared in the 'Reader,' have combated Mr. Croll's views on different grounds; but none of them appear to have seen that they were endeavouring to undermine a house which is supported only by its roof. If an additional proof of the fallacy of Mr. Croll's hypothesis be needed, it will be found in the fact stated in Mr. Godwin-Austen's paper, and noticed subsequently in this Chronicle, that the circumpolar submergence of the glacial period did not extend farther southwards than a line corresponding roughly with that of the Bristol Channel.

A third volume of M. Boucher de Perthes' now celebrated 'Antiquités Celtiques et Antédiluviennes' has recently been published; it contains an account of the discoveries made of late years in the Valley of the Somme, having reference to the antiquity of man, and it will doubtless be read with pleasure by those who take a lively interest in the questions discussed, the more especially as its author was the first to assert that the flint implements of the Somme Valley-gravels were a proof that man existed contemporaneously with the huge extinct mammifers of the Post-pliocene period.

'Die Steinkohlen Deutschland's und anderer Länder Europa's, ihre Natur, Lagerungs-Verhältnisse, Verbreitung, Geschichte, Statistik, und technische Verwendung,* von Dr. H. B. Geinitz, Dr. H. Fleck, and Dr. E. Hartig,' is, as may be inferred from its title, a work of the most comprehensive description. The first volume, being the Geology, by Dr. Geinitz, has just appeared, and forms a valuable work of reference on the German Coal-Fields. In this respect it will be useful; but its value would have been greatly enhanced had more been said about the coal-fields of other countries, and less detail given about those of Germany.

The 'Geological Magazine' commenced the year with a new

* 'The Coal of Germany and other European Countries; its Nature, Stratigraphical Relations, Distribution, History, Statistics, and Technical Uses.'

publisher, at an increased price, and with a considerable improvement in type, style, and general appearance. The articles have also been better than usual, and several deserve special notice. Undoubtedly the most important in the January number is the excellent paper by Mr. C. J. A. Meyer, 'On the Correlation of the Cretaceous Rocks of the South-east and West of England,' in which the author expresses the opinion that the various groups of strata occurring between the top of the "chalk with flints," and the base of the Atherfield clay, were all in turn "deposited beneath the same ocean without serious break or intermission between them," therefore he does not admit that there was a long lapse of time between the deposition of the Lower Greensand and that of the Gault. His views are very clearly illustrated by a most ingenious ideal section from Folkestone to Lyme Regis; and he guards against the possibility of any misconstruction, by observing that "the strictly horizontal arrangement of the groups of strata shown in the section, though true for short distances, is therefore probably incorrect for each and all of the groups, if traced throughout their utmost range, and must be regarded as merely an approximate arrangement; it being, probably, as true for sedimentary strata as for forms of life, that all originated at some given point, and that, consequently, their lateral extension can seldom be represented by a horizontal line."

In the same number, Mr. Etheridge gives a notice of the important discovery of a number of Labyrinthodont Amphibia in the coal-measures of Jarrow Colliery, Kilkenny, and states that Professor Huxley has determined them to belong to five genera, at least four of which are new. There is also a description of an interesting Crustacean—being the first known British species of *Æger*,—by the editor, Mr. H. Woodward; and a very readable article 'On the Raised Beach of Cantyre,' by Mr. Hull.

In the February number, Mr. Binney endeavours to prove, in a paper on the 'So-called Lower New Red Sandstones of Central Yorkshire,' that the said rocks are not of Permian age, but belong to the Millstone-grit series. Professor Owen gives a description of a new Sauroid fish (*Thlattodus suchoïdes*) from the Kimmeridge Clay of Norfolk. Mr. Searles Wood, jun., commences an article 'On the Structure of the Thames Valley and of its contained Deposits;' and Mr. D. Mackintosh makes a grand onslaught on the "atmospheric denudation" theory, in a paper entitled 'The Sea against Rain and Frost, or the Origin of Escarpments.' The author of this last paper expresses himself vigorously, even perhaps dogmatically; and says a great deal that is worth reading. He contends that the sea is not a levelling agent, that rain and frost are incapable of producing cliffs, that the débris under cliffs is of marine origin, the majority of the blocks and fragments found scattered under them having fallen previously to the last emergence of the land, that rain is incapable of abrading hard rocks, and that it would be difficult to exaggerate the denuding power of the sea as a laterally operating and undermining agent. Much might be said for and against these assertions; but we will merely remark that Mr. Mackintosh seems unable to imagine that the action of surface-currents and waves would tend to plane down the surface of a gradually rising mass of land; indeed, the possibility of the bed of a sea or ocean ever having been subjected to such an action does not seem to have occurred to him, for he states that the assumption of "the subaërialists" that the sea tends to plane down the land "is at variance with the generally received principle of physical geography, that the bottom of the sea at any given time is as uneven as the dry land." If the upheaval of sea and ocean beds were always violent and sudden, Mr. Mackintosh would no doubt be right. Mr. Searles Wood's paper contains the enunciation of some important views and statements; but we must postpone their consideration until after the completion of the paper.

Proceedings of the Geological Society.

The very small number of the Society's journal that we have this quarter to notice, contains three or four papers of average importance. Mr. Godwin-Austen's paper 'On the Submerged Forest-beds of Porlock-bay' possesses, perhaps, the greatest interest for the English geologist, as the evidences of geological changes which these beds present are much more complete than those exhibited by the similar deposits in Bridgwater and Swansea bays; "besides which, they better serve to illustrate the nature and order of oscillations of small amount, which have taken place at times shortly antecedent to the present." The chronological sequence, and the nature of the deposits, are in descending order as follows:—(1) Shingle bank, (2) Marine silt, (3) Surface of plant-growth, (4) Freshwater mud-deposit, (5) Forest-growth, (6) Angular detritus. Collating Mr. Godwin-Austen's reading of the evidence, we have the following history of the more recent geological changes which have occurred in this neighbourhood. The Angular Detritus (6) was formed, when the land was at its highest relative level, by subaërial weathering of the rocks on the high ground, and the accumulation of the débris at lower levels during the Glacial Period, and contemporaneously with the deposition of the Boulder-clay in the more northern parts of Britain. On this detrital accumulation forest-trees grew, and attained a great age; the trees were then killed by the deposition of freshwater mud,—the result, probably, of a depression of the land. Water-plants grew on the nearly dry surface of this mud-deposit, on which the trees fell, and the land was probably slightly upheaved; the area was then depressed below the sea-level, and sea-mud with shells of *Scrobicularia piperata* was deposited; again the land was upheaved, and the surface of the mud was converted into meadow. Lastly, a small depression of the surface caused the accumulation of the shingle-bank on the meadow-land. We have thus, in this paper, a beautiful example of the manner in which even the smallest oscillations of level may be traced, in comparatively insignificant deposits, by the practised geologist. But Mr. Godwin-Austen makes still further use of the evidence he has obtained. The Angular Detritus he finds to be the same as that which overlies many of the so-called "Raised Beaches," such as that between Braunton and Baggy Point; consequently, "in a modified sense," these sea-beds or raised beaches are Pre-glacial, or older than the period of deep surface-disintegration. This "modified sense" is really "homotaxis;" for the author observes that "just as the amount of northern depression increased from the south northwards, so the progress of that depression was in the contrary direction, or from north to south. The line of the Bristol Channel was nearly the limit of this submergence, and was the last reached." Respecting the age of the deposits above the Angular Detritus, and the value of the indications they afford, Mr. Godwin-Austen remarks, "that they belong to the time of our existing assemblage of animals and plants, that they indicate changes of small vertical amount, and are remarkably uniform."

In a former Chronicle,* we gave a sketch of Mr. Jamieson's ice-dam theory of the Parallel Roads of Glen Roy, and we have now to notice a paper by the Rev. R. Boog Watson in contravention of that theory, and in support of Mr. Robert Chambers's view of their marine origin, chiefly on the grounds that the sea has been on the spot and is capable of performing the work required. The author's main objections to the ice-dam theory are—(1) that terraces similar to the Parallel Roads, though less perfect, exist at all levels round our coasts, as well as inland, along every fjord in Norway, and across the whole of Sweden; (2) that there are several terraces, even in Lochaber, unconnected with any "col;" and (3) that to provide the mass of ice required for the dams, the relation always observed to exist between glaciers and the snow-field which feeds them, would have to be reversed; that is to say, the snow-field would be minute and the glaciers gigantic. Mr. Watson also contends that the ice-dam theory treats the Parallel Roads as something distinct from other terraces, whereas he considers them specifically the same, the Glen Roy Roads differing only in being more perfectly preserved. The absence of fossils from the Parallel Roads is admitted to be a difficulty in the way of the "Marine Theory;" but Mr. Watson explains it by showing that it "accords with the character of simi-

* 'Quarterly Journal of Science,' vol. i. p 292.

larly-placed beds in every other locality, both in Scotland and in Scandinavia." Mr. Watson defends his position with great ability, and attacks his opponents with a considerable amount of force; and although we cannot ourselves accept his conclusions, we regret that his paper has not been published in full, as all the facts and arguments on both sides of the question should be made equally public.

Dr. Duncan's paper "On Impressions of Selenite in the Woolwich Beds and London Clay," treats of a very curious and little-understood subject, and will, we hope, prepare the way for more complete researches. The impressions have been formed by the decomposition of globular stellate groups of crystals of selenite, and Dr. Duncan discusses the different ways in which the selenite may have been formed and subsequently removed. To geologists, the most interesting point is the probability of the conclusion that "the formation of gypsum, and of its more durable replacing crystalline form, selenite, suggests the decomposition and destruction of organic remains, and the disappearance of these minerals is equivalent to the destruction of the evidence of the former existence of organisms;" consequently, "there is no reason why the purest clay-slate may not have been formed from a fossiliferous clay."

The next paper, by the Rev. O. Fisher, is remarkably ingenious, but very heterodox; it is entitled, "On the Relation of the Norwich or Fluvio-marine Crag to the Chillesford Clay or Loam." The Chillesford Clay has hitherto been considered to be either the equivalent of the Norwich Crag or a little more recent; but Mr. Fisher endeavours to prove that it underlies that deposit and overlies the "Mya-bed," which last stratum he considers to be the one to which should be referred the bed at Southwold, containing Mastodon and other Mammalia; therefore he considers that we ought not to hesitate to include the Chillesford Clay in the Norwich Crag series. The paper is well worth a careful reading, on account of the author having taken so much advantage of even the most minute circumstances to prove, either directly or inferentially, the truth of his conclusion; but that conclusion must appear to an "old-fashion" geologist at least a little improbable.

Captain Godwin-Austen's "Notes on the Carboniferous Rocks of the Valley of Kashmere" are valuable, on account of the sections which illustrate them, and of Mr. Davidson's descriptions and figures appended thereto. The Carboniferous formation may be traced all along the range of mountains on the north side of the Kashmere Valley; and where Mesozoic rocks occur, both in Kashmere and Thibet, they are underlain by strata of Carboniferous age. The Brachiopoda from Thibet determined by Mr. Davidson belong to six Carboniferous, two Jurassic, and two Cretaceous (?) species. Those from Kashmere are all Carboniferous, and number as many as twenty-three species, including many of the common and widely-spread European and American species, together with a few which have not yet been noticed from other parts of the world, and which indicate that the Carboniferous rocks of Thibet, Kashmere, and the Punjab belong to one great formation. From the very scanty notes now published we presume that Captain Godwin-Austen's researches are as yet incomplete, as the abstracts of his communications to the Society already published led us to expect a much more complete memoir. We shall therefore defer examining the questions suggested by the facts already given, until we have the author's own interpretation of them before us.

At the Anniversary Meeting of the Society, held on February 16th, the Wollaston Gold Medal was awarded to Sir Charles Lyell, Bart., D.C.L., F.R.S., F.G.S., &c., in recognition of the highly important services he has rendered to the study of Geology by his various original works, and for the masterly and philosophic manner in which he has treated the subject, both in developing the principles and in expounding the elements on which the science is founded; and the balance of the proceeds of the Wollaston Donation Fund to Mr. Henry Woodward, F.G.S., F.Z.S., to assist him in carrying on his researches on the Fossil Crustacea.

MINING, MINERALOGY, AND METALLURGY.

The depressed state of metal mining in this country still continues. The causes which were named in the Chronicles of our last number are still in operation, nor does there appear any immediate prospect of improvement. The continuance of the war between Spain and Chili, and the declaration of war by Peru, must necessarily in a little time increase considerably the price of copper, and consequently the value of British copper ores. The copper miners of this country may therefore calculate ere long on receiving some returns to compensate them for the losses to which they have been exposed for some years. A very unfortunate, though happily an unusual, contest has sprung up between the copper miners and the managers of the Great Devon Consolidated Copper Mines, and some other mines in the neighbourhood. Angry feelings were so far shown, that it was felt necessary to call in the aid of the military. The questions—those of wages and time—are now, it is hoped, in progress of settlement by arbitration.

Lord Kinnaird has again brought his Metalliferous Mines Bill before the House of Lords. It has been considerably modified from the bill which his Lordship withdrew last session. Sir George Grey stated, in reply to a question asked in the House of Commons, that the Government intended to bring forward a bill for the better regulation of metalliferous mines.

In our last we referred to the discoveries of silver said to have been made in California. We said we should watch the result with much interest, and we have reasons now for placing our readers on their guard. The reports of some English engineers who have been sent out to examine the district are by no means satisfactory. For example, reports of the following description from Austin-Nevada are not encouraging:—"We are on the eve of bad times; rascality and bad management have been doing their evil work; owners of '*wild cat*' sold claims at high prices; hundreds of stamps will stand idle for months to come," &c., &c. One gentleman of eminence in his profession will shortly return to this country; from him we may expect reliable information. In our next we hope indeed to furnish a report on the wonderful "Silver-peak" and the adjoining argentiferous district.

The "Comité des Houillères Françaises," according to their annual custom, have just issued their "Situation de l'Industrie Houillère en 1865." From this publication we learn that the production of coal from the French collieries in all the Departments amounted to about ten millions and a-half English tons. The French received for consumption, in addition to their own produce, from

	Tons.
England	1,285,514
Belgium	3,136,790
Prussia	873,270

They also imported 651,930 tons of coke from these countries.

The American government have lately published a very important volume, showing the industrial resources of the United States and their commercial relations with foreign countries. From this we extract the following information respecting the coal produce of Eastern Pennsylvania and the bituminous coal trade of Maryland.

Eastern Pennsylvania—*Hard Anthracite.*

	Schuylkill, Tons.	Lehigh. Tons.	Pinegrove. Tons,	Shamokin. Tons.	Wyoming and Lackawanna. Tons.	Aggregate.
1860	3,234,844	1,821,674	145,181	201,108	3,114,162	8,316,969
1861	2,644,402	1,738,387	168,148	241,451	3,243,730	8,036,118
1862	3,286,330	1,278,801	209,851	241,642	3,291,037	8,307,661
1863	3,703,964	1,894,713	203,991	274,936	3,777,447	9,855,051
1864	3,763,874	2,053,506	204,000	333,478	4,083,053	10,437,911
1865	3,835,916	2,291,017	157,840	457,162	3,341,158	10,083,093

Eastern Pennsylvania.—*Semi-Anthracite and Bituminous.*

	Lykens Valley. Tons.	Treverton. Tons.	Broad Top. Tons.	Blossburg. Tons	Barclay. Tons.	Aggregate. S. A. & Bt. Tons.
1860	176,274	90,448	187,853	97,571	27,718	579,868
1861	170,392	46,656	272,709	112,713	40,835	643,205
1862	177,121	63,223	333,606	179,334	52,779	806,063
1863	141,282	62,000	305,678	226,183	54,116	789,259
1864	129,973	66,000	386,645	353,124	62,010	997,752
1865	..	..	315,996	..	..	..

Maryland (*Cumberland*)—*Semi-Anthracite and Bituminous.*

	Tons.
1860	666,572
1861	269,674
1862	317,631
1863	748,345
1864	657,996
1865	522,356

Summary of 1864.

	Tons.
Eastern Pennsylvania—Hard Anthracite	10,437,911
,, Semi-Anthracite and Bituminous	997,752
Maryland (Cumberland)—Semi-Anthracite and Bituminous	657,996
	12,093,659
The other coal-producing States	2,500,000
Total Coal-produce of America .	14,593,659

The Foreign Office has just issued a series of 'Reports received from Her Majesty's Secretaries of Embassy and Legation respecting Coal.' These Reports originated in a circular issued in 1865 by Earl Russell, and sent to all countries producing coal, or with whom England had any trade for coal, requiring—

1. A statement of the coal-fields actually worked, and the development in production.

2. A statement of the external trade of each country in coal.

3. The ratio in which each country draws its supplies from Great Britain.

Reports from twenty-eight countries have been furnished. An Appendix gives 'Extracts from Commercial Reports by Her Majesty's Consuls;' these are short, but nevertheless valuable notes respecting twenty-two places in various parts of the world producing coal or receiving British coal.

Such returns should possess considerable value. Unfortunately, the questions were committed to the care of a class of men, who, from their training, are entirely unfitted to answer them with any approach to correctness. The Secretaries of Embassy and Legation have never before been taxed with an inquiry such as this. They have consequently taken such information as came to their hands, and it is evident that they have not often troubled themselves to obtain the most recent. Austria, Prussia, and Belgium, for example, publish annually very complete returns of the mineral productions of each country. The returns for 1864 were very readily obtainable, yet 1862 is regarded as the most recent returns by the reporters. The American Government have lately published a valuable return, from which we have quoted; but the return of Mr. Burnley is almost entirely derived from Taylor's 'Statistics of Coal,' the latest edition of which was published in 1855, and that edition was little more than a reprint of a very much older book, which has never been regarded as an authority, by those who had paid any attention to the important question of coal production. The errors in this book of Reports presented to both Houses of Parliament are curious and serious. We are gravely told that "an eminent geologist estimates the average thickness of the workable coal of Great Britain at thirty-five feet, and the total quantity of workable coal at 190,000,000 tons." This is bad news for us. Seeing that we are now obtaining from our collieries about 95,000,000 tons per annum, we have but two years' supply. Of Russia it is said, "There is, perhaps, no country in Europe where such *large* coal districts exist as in Russia." The truth is, there is no country in Europe, of such large extent, where such *small* coal districts exist.

As the Reports are intended for English readers, it is to be regretted that some uniform weight has not been adopted. Instead of this we have the weight in use in each country given, and in many instances without any explanatory note. We have Zoll-verein cwts., centners, metrical quintals, Prussian tonnen, Swiss "colliers" and half-mudden, continually perplexing us. Much valuable matter is to be gleaned out of the mass; and if the Secretaries of Legation are properly instructed as to the kind of return which they will be expected to make in future years, these Reports on coal may have a permanent commercial value.

Mr. St. John V. Day, of Glasgow, reports that the Rankinstone shale yields of crude paraffin oil thirty gallons, and of ammoniacal liquor twelve gallons, from the ton of shale. Several other shales in Fifeshire—the West Calder district and other places—have been examined with similar results. In Northamptonshire it has been found that the cannel coal of Hucknal Forehard Colliery gives forty-three gallons of crude oil to the ton. Extensive works are, in consequence, being erected.

We learn from the Australian newspapers that a substance resembling cannel coal has been found at Hartley and Wollongong, in New South Wales, and that a company has been formed for the manufacture of oil from it. It is stated that this cannel coal yields 147 gallons of oil to the ton; but we are not informed whether this is crude or refined oil. We of course infer the former. The question then arises, What is the value of this crude material for refined oil?

While writing this a report comes to our hands from Julius W. Adams, Engineer, Broadway, New York, on the principles and methods used by Mr. Simon Stevens for burning petroleum and other hydrocarbons in combination with jets of steam. The result, as given, is that 29·33 pounds weight of water at a temperature of 60° will be converted into steam by the combustion of one pound of oil; whereas it is said 8·16 pounds only of water at 60° can be converted into steam of atmospheric pressure by one pound of anthracite coal. This of course requires confirmation by a continuance of the experiments. It must, however, be admitted that Mr. Richardson's experiments in this country were satisfactory.

Nitroglycerine has been much lauded as an explosive agent for mining purposes. It is now stated* that it freezes at a temperature of about 42° Fahr., when mere friction will occasion it to explode. In one of the Silesian mines an overseer was attempting to break a frozen mass, weighing about eight pounds, when it exploded, and the poor man was blown high into the air, and, of course, killed.

M. Simon communicates in a letter to M. Élie de Beaumont some interesting particulars respecting the Stanniferous deposits of Brittany. The district of Villeder consists of a system of quartz veins in contact with granites and schistose rocks, the direction of the principal veins being N.N.E. Penestin (in Breton *Pen-staen*, the Headland of Tin), Piriac, and Morbihan are all tin-producing districts, and it is thought that the embouchures of the Vilaine and the Loire were visited by Phœnicians and the Greeks in the time of Homer. To these points M. Simon would call the attention of modern tin miners, especially as the districts correspond with the rich tin-bearing districts of Cornwall.†

Mineralogy.

Knop has recently discovered in the decomposed and weathered cryolite a new mineral, to which he has given the name *Pachnolite*, from its resemblance to hoar-frost. Knop gives the chemical composition as Fl. 50·79, Al. 13·14, Na. 12·16, Ca. 17·25, H. 9·60= 102·94.‡ Dr. G. Hagemann, of the Alkali works at Natrona, in Pennsylvania, has examined this mineral, and he fully confirms M. Knop's results. It appears that cryolite is now imported largely to Natrona from Greenland, for the purpose of manufacturing soda-ash, alumina salts, and other products.§

Professor W. P. Blake states that a mass of gold, which is for the most part a congeries of imperfect crystals, has been found seven miles from Georgetown, El Dorado Co., California, which weighs 201 ounces.‖

The amount of gold and silver produced in 1865, from the mines of the Montana Territory, will be sixteen millions of dollars. The region was a wilderness in 1862.¶

An iron ore of peculiar character has been discovered in Ireland. It has much the appearance of Plumbago, leaving a greasy stain when rubbed between the fingers, and giving off under the knife

* 'Berg und Hütten-mannische Zeitung.'
† 'L'Institut,' Feb. 21, 1866. No. 1677.
‡ 'Annalen der Chemie und Pharmacie,' vol. cxxvii.
§ 'American Journal of Science and Arts,' Jan., 1866.
‖ Ibid. ¶ Ibid.

glistening particles of a metallic lustre, not unlike mica. It was unacted on by the blow-pipe, and contained no carbonaceous matter. Its composition was stated, at a meeting of the Geological Society of Glasgow, to be—Ferric oxide 90·5, Insoluble matter in HCl and NO_5 9·5=100. This was, without doubt, a peculiar variety of micaceous iron ore.

Dr. Tschermak's "Researches on the Group of Felspars," referred to in our last number, have called forth a paper by Professor Rammelsberg, "On the Composition of Oligoclase and Labradorite, &c." (Ueber die Zusammensetzung von Oligoklas und Labrador, &c.).* Although the different members of the felspar family consist of double silicates, which invariably contain one atom of protoxide to one atom of alumina; or, in other words, in which the oxygen of the protoxide bears to that of the sesquioxide the constant ratio of 1 : 3, yet there probably exists no felspar which contains only a single protoxide. Thus in ordinary orthoclase-felspar, the potash is always accompanied by soda, which sometimes reaches so high a percentage that certain forms of sanadine or glassy felspar contain as much as one atom of soda to one of potash; and the same is the case with the orthoclase from the Norwegian zircon-syenite. These soda-bearing potash-felspars are probably to be regarded as regular associations of orthoclase and albite; such, at least, is certainly the case with the mineral called Perthite. Extending this idea, Tschermak supposed that the existence of soda in *all* potash-felspars was referable to the presence of associated albite, as proved by analysis; but Rammelsberg objects that this is a point which can be determined, not by chemical analysis, but only by physical research; and that this has hitherto failed to prove the existence of albite in such compounds. Thus, according to Rammelsberg's own analysis, the glassy felspar from the trachyte of the Drachenfels on the Rhine, contains 10·32 per cent. of potash, and 3·42 of soda, corresponding to 57 per cent. of orthoclase and 43 of albite; the mineral thus consisting, according to Tschermak's theory, of one atom of albite and two of orthoclase: yet this mixed felspar, in which albite forms no less than one-third of the mass, in nowise differs, either in crystalline form or in optical properties, from the purest adularia. Such cases might, however, be explained by regarding the mineral as an isomorphous combination of potash-orthoclase with a soda-orthoclase unknown in an isolated form, but which evidently must be a monoclinic compound, and not a triclinic albite.

Rammelsberg regards as equally inconclusive Tschermak's explanation of the presence of potash in albite, and of potash and soda in anorthite; physical observation having shown that orthoclase is not present in albite, nor othoclase and albite in anorthite.

* 'Poggendorff's Annalen,' 1865. No. 9.

Passing to the other felspars—Oligoclase, Labradorite, Andesine, &c.—the author agrees with Tschermak in regarding these different forms of soda-lime felspar as isomorphous compounds of anorthite and albite in definite proportions—a conclusion at which Rammelsberg arrives by an elaborate tabulation of a very extensive series of analyses, and which is corroborated by certain crystallographic considerations.

At the conclusion of this paper we are reminded that the idea of regarding the middle terms of the felspar series as mixtures of the two extremes, is an idea which by no means originated with Tschermak, but which has been worked out in different ways by Waltershausen, Hermann, and others.

To the same number of 'Poggendorff's Annalen,' Herr Schmid contributes three mineralogical papers. The object of the first of these is to correct the formula established by Von Kobell, for the hydrous silicate of lime called *Okenite*, and which is always expressed as $3\,CaO, 4\,SiO_3 + 6\,HO$. The author shows that one-sixth of the water present is simply hygroscopic, and may therefore be expelled at ordinary temperatures; and that a second atom may be driven off at a higher temperature, and may hence be compared to "water of crystallization;" the remaining four atoms being true "water of combination," essential to the constitution of the mineral. These three conditions of Okenite may be thus represented:—

(1.) $3\,CaO, 4\,SiO_3 + 6\,HO$
(2.) $3\,CaO, 4\,SiO_3 + 5\,HO$
(3.) $3\,CaO, 4\,SiO_3 + 4\,HO$

In the second paper, Herr Schmid describes the aragonite from the Zechstein of Kammsdorf, near Saalfeld in Thuringia. The mineral occurs in small bundles of diverging crystals, locally called "needle spar" (Nadelspath); the crystals often presenting twin forms, and when colourless consisting simply of carbonate of lime with the merest trace of magnesia. This aragonite is interesting as a dimorphic form of *pure* calcic carbonate, the entire absence of strontia and baryta—constituents commonly present in this mineral—having been determined by spectrum analysis.

The examination of three varieties of psilomelane forms the subject of the third paper, and leads the author to adopt for this unsatisfactory species the formula of $(MnO, BaO), 4\,MnO_3 + 6\,HO$.

Dr. F. Wibel has written an interesting paper on "The Alteration-Products of Ancient Bronzes: a Contribution to the Origin of certain Copper Ores, especially the Red Oxide" ("Die Umwandlungs-Produkte alter Bronzen: ein Beitrag zur Genesis einiger Kupfererze insbesondere des Kupferoxyduls").† The green coating of cupreous

* 'Ueber Okenit;' 'Ueber den Aragonit von Gross-Kammsdorf bei Saalfeld;' and 'Ueber Psilomelan.'

† 'Jahrbuch für Mineralogie,' &c., 1865. 4 Heft.

carbonate, exhibited in a greater or less degree by all old bronzes, and which is well known to antiquaries as *patina*, is often accompanied by suboxide of copper, occurring usually in small octohedral crystals, greatly resembling those of the native mineral. This suboxide is generally in immediate contact with the metal, and therefore beneath the external coating of carbonate—a disposition with which the mineralogist is familiar, as occurring in certain specimens from copper lodes, which exhibit a nucleus of native copper surrounded by red oxide, and this again by malachite. Both the natural and the artificial specimens are commonly supposed to have been formed by the action of atmospheric influences on the metal, producing first an oxide, and finally a carbonate; both being regarded as products of oxidation. From carefully conducted observations on ancient bronzes, the author is enabled to oppose this commonly received opinion, and to show that the red oxide of copper, so far from being a product of oxidation, is, in truth, a product of reduction. By the action of water charged with oxygen, carbonic acid, and various salts, there are first formed upon the bronzes certain soluble cupreous salts, which afterwards suffer reduction, either partially to the condition of suboxide, or completely to that of metallic copper.

Some valuable chemico-mineralogical views are set forth by Dr. Streng in an able memoir " On the Composition of certain Silicates, with especial reference to Polymeric Isomorphism " (" Ueber die Zusammensetzung einiger Silicate mit besonderer Berücksichtigung der polymeren Isomorphie "). Without crowding our pages with what Dr. Hofmann aptly enough terms the "Algebra of Chemistry," it would be impossible to explain Dr. Streng's views.

The mineral *orthite*—a silicate of alumina, protoxide of cerium—has been recently discovered by Sandberger at Dürrmosbach, near Aschaffenburg, in the Spessart.* It occurs in brownish-black lustrous granules or crystalline fragments in an anorthic felspar, thus presenting another example of the association of cerium-bearing minerals with lime-and-soda felspars.

In the Italian section of the International Exhibition was a specimen of "fine siliceous sand," occurring on the shore of the Adriatic, near Pesaro, where it is used for cutting hard stones, sawing marble, &c. This sand has been examined by M. Pisani,† who finds it to be garnetiferous. Granules of magnetic iron ore having been removed by the magnet, and carbonate of lime dissolved out by hydrochloric acid, the residue consists chiefly of rose-coloured grains, which are proved by analysis to be true garnet of the variety called almandine.

* 'Orthit im Spessart.' 'Würzburger Naturwissenschaftliche Zeitschrift,' 6 Band, 1 Heft, p. 43.

† 'Sable granatifère de Pesaro; Thulite de Traversella; Bustamite du Vicentin.' 'Comptes Rendus,' No. 2, 1866.

The pink epidote known as *thulite* is described by Pisani from near Traversella, in Piedmont, where it occurs in small veins, associated with talc and green hornblende in a granite rock.

The same chemist also announces a new locality for the rare mineral *Bustamite*, a silicate of manganese, containing lime, hitherto found only in Mexico. The specimen analysed by Pisani came from Monte Civillina, between Schio and Valdagno, in Italy.

A visit to the locality of the aluminium ore *Bauxite* has enabled M. Virlet d'Aoust to present to the Geological Society of France certain "Mineralogical and Geological Notes on the Pisolitic Aluminous Iron Ore of Mouriès, called also Les Baux" ("Notes Minéralogiques et Géologiques sur le Minerail de fer Alumineux Pisolithique de Mouriès, dit aussi des Baux").*

Professor Maskelyne announces† that he has received from Mr. Talling, of Lostwithiel, a new Cornish mineral, described as a finely-granular greenish-blue substance, which proved on analysis to be "a hydrated aluminic (with traces of calcic) silicate, tinted rather deeply with a cupric silicate. It is doubtless an opal allophane, the Saltzburg variety of which mineral it closely resembles."

The literature of mineralogy has been recently enriched by the publication of the first volume of an admirable 'Treatise on Physical Mineralogy,' by Dr. Albrecht Schrauf, of Vienna.‡ The present volume—devoted exclusively to Crystallography and Mineral-Morphology—contains an interesting outline of the history of Crystallography and Crystallogenesis, followed by several chapters on Homœomorphism and Pseudomorphism. Considerable space is then devoted to Theoretical Crystallography, the system adopted being that of Miller and Neumann, with certain modifications introduced by the author. The different forms of goniometer are then described, and ample instructions given both for taking measurements and for reckoning the results. At the close of the volume is a useful table giving a comparative view of the crystallographic symbols of different authors. The present work is intended as a companion to the author's 'Atlas der Krystall-formen des Mineralreiches,' an elaborate work, to be completed in twenty parts, of which the first appeared a few months ago, comprising ten beautifully executed plates of crystalline forms. In these comprehensive works Dr. Schrauf appears to be doing for Physical Mineralogy what Rammelsberg has already done for the Chemistry of the Science.

Metallurgy.

In the Proceedings of the American Academy we find a claim put forward by Professor Asa Gray, in favour of Professor Tread-

* 'Bulletin de la Société Géologique de France.' 2nd Series, vol. xxi[?]. p. 418.

† 'Chemical News,' Feb. 16, 1866.

‡ 'Lehrbuch der Physikalischen Mineralogie,' von Dr. Albrecht Schrauf. 1 Band. 'Lehrbuch der Krystallographie und Mineral-Morphologie.' Wien, 1866.

well, as being the inventor of the so-called "built-up guns," and for which the Academy awarded him their Rumford medal.

Professor Gray quotes Professor Treadwell's own language: he says, "Between 1841 and 1845 I made upwards of twenty cannon of this material (wrought iron). They were all made up of rings, or short hollow cylinders, welded together endwise; each ring was made of bars wound upon an arbor spirally, like winding a ribbon upon a block, and, being welded and shaped in dies, were joined endwise when in the furnace, at a welding heat, and afterwards pressed together in a mould by a hydrostatic press of 1,000 tons force." This and sundry other matters bearing on this question are stated to have been published in 1845, and that a French translation of the pamphlet was published in Paris in 1848 by a Professor in the School of Artillery at Vincennes.

We feel assured that Sir William Armstrong will not dispute Professor Treadwell's claim. The manufacture of "built-up guns" is very much older than the American Professor. We have in Edinburgh "Mons Meg" as an example, and similar guns which were used at the siege of Calais are still preserved, and gun-barrels have long been made in this way. Professor Asa Gray repeatedly contrasts Professor Treadwell's gun with Sir William Armstrong's, failing, apparently, to see that the "coiled cylinders" are only a part, and a very small part, of the arrangements adopted in the construction of the Armstrong gun. No doubt Professor Treadwell's guns are of a high character, and he fully deserves the encomiums passed upon him on the delivery of the medal.

Mr. Mosheimer, who was for a long time connected with the gold mines in North Wales, is now engaged in experiments with the sodium process of Mr. Crookes in California. He gives the following statement of the results of his experiments:—"I worked the same ore, side by side, with the same machinery, and the results were as follows:—*First lot* of 500 lbs. Each pan with sodium yielded 85 per cent. of the assay; without sodium the yield was only 55 per cent. *Second lot*—different ore—with sodium, 80 per cent.; without sodium, 60 per cent. *Third lot*—different ore—with sodium, 78 per cent.; without sodium, 60 per cent." We make no comment on these results.

Mr. E. H. Newby, of London, has patented a process for increasing the strength of iron, and rendering it less liable to corrosion. It is, at all events, curious enough to be recorded, whatever may be its value. Twenty-five pounds of zinc, two-and-a-half pounds of tin, five pounds of copper, and one-fifth of a pound of aluminium, with two pounds of borax, and one pound of the permanganate of potash, are first melted together; then a thousand pounds of "white iron" are gradually added, and the whole incorporated. The resulting iron is said to be "very strong and pliable, and little liable to be corroded by acids." The metallurgical chemist will be rather puzzled to determine which of the agents in the alloy is the most effective.

Mr. F. Claudet proposed to economize the oxide of iron resulting from the decomposition of the cupreous pyrites, as practised at Mostyn, at Newcastle, and other places, by moulding it into bricks by means of plaster of Paris. These, after they have been dried, can be used in the blast furnace as any ordinary iron ore.

M. H. Caron has a clever paper, in a recent number of 'Les Mondes,' on blistered steel, in which he gives the results of his experiments and observations. He is disposed to refer the formation of these blisters to carbonic oxide, but he admits the necessity of a more extensive series of experiments.

The Managing Director of the Bolton Iron and Steel Company writes us as follows:—"In your January number for this year you publish a statement illustrative of the powers of modern metallurgy, and after describing the large 'block of steel' cast at Messrs. Bessemer & Sons' works at East Greenwich, you go on to say that 'large as this block is, it was far exceeded by what has been done at Bolton by the "aid of" Messrs. Ireland & Sons' patent upper twyer cupola furnaces, where a block of steel weighing 250 tons was cast. This furnace melts at the rate of thirteen tons of Bessemer steel in an hour,' &c., &c. As managing partner of the Bolton Iron and Steel Co.'s works, I think it my duty to correct this statement; and without wishing to detract in the least from the value of Messrs. Ireland & Sons' patent cupolas, which did their work in a most satisfactory manner on the occasion alluded to, I may state that the block in question is one of four which Mr. Ireland cast at these works, but it is of iron and not steel, and the weight is something over 205 tons. A small quantity of Bessemer steel scrap was melted down along with the pig-iron, in place of putting in cold blast iron, and the time occupied in casting the block was ten hours from the blast being put on to the cupolas, including the stoppages necessary for the workmen to take refreshment. I believe the block cast at Messrs. Bessemer & Sons' works was entirely of iron."

IX. PHYSICS.

Light.—The Academy of Sciences have bestowed the Bordin Prize of 1,500 francs upon M. Janssen for a memoir "On the Terrestrial Lines of the Solar Spectrum." The following abstract of the memoir will show the author's line of research:—Sir David Brewster many years ago discovered in the solar spectrum certain dark bands which become more and more marked as the sun descends towards the horizon. These bands, considered as to their real constitution and origin, have been the subject of long and persevering researches by the author, the principal results of which are contained in the memoir submitted. The bands have been resolved into fine and well-defined lines, visible in different degrees at all heights of the sun. A variety of proofs allow of distinguishing with much probability these particular or *telluric* lines from the lines pre-existing in solar light. Lastly, if the whole of these lines appear to have the terrestrial atmosphere for a common origin, a certain number of them would appear to be caused by the presence of the vapour of water in the atmosphere. The memoir gives a special account of the author's experiments on the Faulhorn—that is to say, at a height of 2,683 mètres—where he found that these telluric lines were much less visible than in the plain. It contains also an account of an experiment made at Geneva, which seems to show more conclusively that the cause of these lines resides in the atmosphere. The author made a large bonfire at night, and examined the light first close by, and then at a distance of twenty-one kilomètres. In the first case the spectrum remained continuous; but at the distance just mentioned the telluric lines were clearly seen.

In a memoir by M. J. Nicklés, "On the Effects of Colouration and the Extinction of Colours produced by Artificial Lights," the author has suggested a good lecture experiment. With the following pigments he paints a spectrum, which shows all the colours either by gas or candlelight, but shows only black and white with a soda flame (alcohol and salt).

Colour by daylight.	Pigment.	Colour by Soda flame.
Red	Ochre	Black.
Orange	Biniodide of mercury	White.
Yellow	Chromate of lead	White.
Green	Manganate of baryta	Black.
Blue	Aniline blue	Black.

At a recent meeting of the Chemical Society, Mr. C. R. Wright read a paper, entitled "Contributions to our Knowledge of the Chemical Action of Sunlight upon Sensitive Photographic Papers." Following the method adopted by Mr. McDougall, and described in his paper ('Journal of the Chemical Society,' vol. iii., p. 183), the author proposed to determine the relative degrees of sensitiveness exhibited by papers coated with the chloride, bromide, and iodide of silver, and mixtures of these, in the proportion of single equivalents, in the presence of a constant excess of nitrate of silver. The conclusions established by the author's experiments are stated in the form of eight propositions; but the general nature of the results may be gathered from the subjoined table, which describes the relative degrees of sensitiveness observed when the several papers were referred to a normal tint; thus:—

Chloride of silver paper	1000
Chloro-iodide of silver	1078
Chloro-bromide of silver	4022
Bromide of silver	2396
Bromo-iodide of silver	4060

M. Poitevin has lately succeeded in producing photographs on paper in their natural colours. He prepares his sensitive paper in the following way:—Having obtained a layer of violet subchloride of silver on the paper, by the action of light on the white chloride in the presence of a reducing agent, he applies to the surface of the paper a liquid composed of one volume of a saturated solution of bichromate of potash, one volume of saturated solution of sulphate of copper, and one volume of a solution containing five per cent. of chloride of potassium. This paper is dried and kept in the dark; it will keep good for several days. In this mixture the bichromate of potash is the principal agent, the sulphate of copper facilitates the action, and the chloride of potassium preserves the whites which are formed. In copying paintings on glass, the exposure to direct light need only last five or six minutes; but the time must, to some extent, depend on the transparency of the picture to be copied, and it is easy to watch the development of the image on the paper. The paper is not sufficiently sensitive for use in the camera. To preserve the pictures it is only necessary, first, to wash them with water acidulated with chromic acid, then to treat them with water containing bichloride of mercury, afterwards with a solution of nitrate of lead, and, lastly, well wash them with water. After that they will not change in ordinary light, but will, however, turn brown in direct sunlight.

In order to prepare a window for the illumination of a photographer's dark-room, Obernetter mixes an acid solution of sulphate of quinine with some gum or dextrine, and paints the mixture over a thin sheet of white paper. With this he covers the window-panes, and he states, that on the brightest day a window so prepared will allow no actinic light to pass. This we doubt. The strongest solution of sulphate of quinine allows some of the photographic rays of light to pass through, and it is not likely that paper coated with the salt would be more impervious to the actinic rays than the solution itself.

The micro-spectroscope has received its first application to medico-legal purposes in the examination for blood-stains of the hatchet supposed to have been used in the Aberdare murder. Dr. Bird Herapath, F.R.S., who was retained by the Crown, placed sections of the handle in distilled water, and submitted the solution obtained to an examination in this instrument. Within the green and on the border of the yellow rays, the well-known characteristic dark bands of blood were produced. Only one other substance was known to produce similar dark bands—cochineal dissolved in ammonia—in which case, however, their position would be different. Dr. Herapath said he was satisfied from the evidence this test had afforded, that the hatchet had been stained with blood.

HEAT.—An important paper by Professor Tyndall has lately been presented to the Royal Society. It is divided into ten sections. In the first, the experiments of Sir William Herschel and of Professor Müller, on the sun's radiation, are described. In the second are given a series of measurements, which show the distribution of heat in the spectrum of the electric light. In the third section is described a mode of filtering the composite radiation of an intensely luminous source, so as to detach the luminous from the non-luminous portion of the emission. The ratio of the visible to the invisible radiation determined in this way is compared and found coincident with the results of prismatic analysis. The eminent fitness of a combination of iodine and bisulphide of carbon as a *ray-filter* is illustrated. In the fourth section, experiments with other substances are described; various effects obtained in the earlier experiments on the invisible rays being mentioned. In the fifth section, the absolutely invisible character of the radiation is established; it is also proved that no extra-violet rays are to be found at the obscure focus. Numerous experiments on combustion are also described in the fifth section. The sixth section deals with the subject of *calorescence*, or the conversion of obscure radiant heat into light. In section seven, various modes of experimenting are described, by which the danger incident to the use of so inflammable a body as the bisulphide of carbon may be avoided. In the eighth section are described experiments on the invisible radiation of the lime-light and of the sun. In the ninth section, the effect obtained by exposing papers of different colours at the dark focus are mentioned; while the tenth and concluding section deals with the calorescence obtainable from rays transmitted by glasses of various kinds.

In a subsequent paper on radiation and absorption, Professor Tyndall considers the department of certain additional elementary bodies towards radiant heat. He exposes powders and liquids of the same physical character, but differing from each other chemically, at a focus of dark rays, and describes the different effects produced. He examines and explains the experiments of Franklin on the absorption of solar heat. He then determines the radiating power of a great number of substances in the state of fine powder, and finds, contrary to the current belief, that in this state also chemical constitution exercises a paramount influence. The results obtained by previous experimenters in connection with this subject are illustrated and explained. The reciprocity of radiation and absorption on the part of fine powders is also illustrated. It is, moreover, shown that the heat emitted from different sources, at a temperature of 1,000° C., varies in quality, this being proved by its unequal transmission through plates of rock salt of perfect purity. The absorption by such plates varies from 4 to 30 per cent. of the incident radiation.

Magnus has published a memoir "On the Difference between the Heat Radiated from Polished and Unpolished Surfaces." The author has made the important observation that a plate of platinum covered with platinum black radiated twice as much heat as a plate of polished platinum of equal extent; and on analyzing the radiations he discovered that the increase of heat from the unpolished metal is not due to a regular increase in all the rays emitted, but that the red, and especially the ultra-red, rays are chiefly augmented in intensity. The whole paper is of great interest, especially the author's final considerations on the identity of heat and light.

A notice of an interesting property of sulphocyanide of ammonium has been published by Mr. F. Clowes. He finds that when dissolved in water this salt produces intense cold; in a short time the atmospheric moisture being deposited like hoar-frost on the sides of the vessel.

This led him to try a few experiments with weighed quantities of water and of the salt; from a few trials with different proportions, it appeared that the mixture of equal parts by weight gave the most intense cold. By mixing 1,368 grains of the salt with its weight of water at 17° C., a cold of —12° C. was obtained; the temperature of the atmosphere at the time of the experiment was the same as that of the water employed.

Electricity.—A very interesting experiment has been described by M. Cauderay. He introduces an electro-magnet into the circuit of a galvanic pile, and, breaking the circuit at any point, places the ends of the two conducting wires, separated one from the other, in a box containing metallic filings, such as silver, copper, brass, or iron. The metallic particles will of course complete the circuit. If, now, one of the conducting wires be slowly raised, a small chain, formed by the juxtaposition of the metallic particles, will be drawn out, and if the experiment be made with great care, every particle in the box can be drawn out in one long chain. The author states his opinion that the adhesion of the particles is not due to magnetization, but is the result of a sort of autogenous soldering by a superficial fusion of the metallic particles. The same author has shown that metallic filings offer very great resistance to currents of dynamic electricity, and upon this principle constructs a new and very cheap rheostat.

M. Hempel has noticed a curious fact respecting the electric conductibility of hyponitric acid. He states that with a powerful machine in full activity and giving strong sparks, the sparks cease and the machine loses all its tension if a vessel containing nitric acid and some copper-turnings be placed so that the red vapours of hyponitric acid may escape into the space traversed by the spark. The tension of the machine reappears as soon as the vessel is removed and the red cloud has been dissipated. To succeed well with this experiment it must be made in a dry atmosphere, or nitric acid will be produced.

Mr. G. Jean has, by means of electricity, succeeded in the splitting up of carbonic acid into ozonised oxygen and carbonic oxide. The author employs an induction coil, provided with a peculiar condenser, for dividing the spark into an infinite number of very feeble sparks. By this apparatus, he says, he proves that carbonic acid, under the influence of the sparks, splits up into carbonic oxide and oxygen; and the odour and other tests showed that the oxygen is strongly ozonised. Atmospheric air exposed to the same influence becomes ozonised, and forms nitric acid (?), which suddenly decomposes into nitrous acid when the air is heated. Ozonised oxygen, the author says, has the property of giving rise to vapours when mixed with sulphurous or nitrous acids, and these vapours are very persistent in the presence of ammonia and iodine. Crystals of iodine dropped into a vessel of ozonised oxygen also gives rise to a very thick vapour, which gradually precipitates in the form of iodic acid. A coating of linseed oil on glass exposed to ozonised oxygen became dry in an hour, and its weight was found to have increased by 20 per cent. The quantity actually absorbed, the author stated, must have been much more considerable, for it was disengaged in the form of strongly-smelling acid vapours.

A paper "On Deaths by Lightning and their Division between the Sexes" has been communicated to the Academy of Sciences by M. Boudin. In a former paper the author showed that more men than women were killed by lightning in France. He now adds statistics for 1864, in which year 87 people were killed, 61 males and 26 females. Putting together his figures, and making a guess for the three new departments, he calculates that in the period of thirty years there have been in the France of to-day 2,431 deaths by lightning. He adds, that the total number of individuals injured is at least four times that of the number killed outright. Thus, the whole number struck from 1835 to 1864 inclusive must have been 12,000, or 400 a year. From 1854 to 1864 inclusive, 967 people were killed in France, 698 being males, and 269 being females. The females, therefore, only constitute 28 per cent. of the victims. In England, M. Boudin adds, the proportion of females is even lower, being only 22 per cent. Referring to the circumstance that when lightning has struck a group composed of individuals of both sexes, the men have been killed and the women escaped, M. Boudin is at a loss how to account for this comparative immunity of the female sex. The 'Chemical News,' commenting on the above paper, suggests that a ready explanation is to be found in the fact that men are, on the average, taller than women.

X. ZOOLOGY AND ANIMAL PHYSIOLOGY.

One of the most important facts which we have to chronicle this quarter in relation to zoological science is the formation of the new chair of Comparative Anatomy and Zoology in the University of Cambridge. The election of the two professors came off about a month since. Dr. G M. Humphry, F.R.S., of Downing College, was unopposed for the older professorship of human anatomy. For the other chair there were two candidates, Dr. Drosier of Caius College, and Mr. Alfred Newton of Magdalene, whose valuable ornithological researches are sufficiently well known. The latter gentleman was elected by a majority of 110 to 82.

The new museum of comparative anatomy at Cambridge—which has been erected within the last year by the University—contains a very valuable and select collection, and is now almost completely arranged, offering a further guarantee of the interest taken at Cambridge in the progress of biological science.

The publication of Professor Owen's work on the anatomy of the vertebrates is an event of some interest; two volumes have appeared, and the third has yet to come.

M. Edmond Alix describes the organs of parturition in Bennett's Kangaroo (*Hilmaturus Bennettii*). He seems to have satisfactorily determined that the view put forward by Sir Everard Home (perhaps derived from John Hunter) with regard to the communication between the cavity of the median vagina and that of the uretogenital vestibule is correct, and that both Cuvier and Owen have been wrong in denying it. M. Alix claims for M. Jules Verreaux the discovery of the mode of parturition in the kangaroo.* Mr. Verreaux kept a large number of these animals in captivity, and by attentive care day and night he was able to ascertain the following facts. When the female feels that she is about to expel an embryo, she applies her two anterior paws to each side of the vulva, so as to open its lips; then she introduces her muzzle, and receives the

* See also our last Chronicle for an account of the parturition of the opossum, which appears to differ very materially.

embryo into the buccal cavity. The aperture of the marsupial pouch is then opened by the paws and the embryo dropped into it from the mouth, when it soon attaches itself to the mammary gland. Both Owen and Bennett had guessed these facts, but M. Verreaux was the first to observe them.

Dr. J. E. Gray has received a letter from Dr. Hermann Burmeister, of Buenos Ayres, communicating the discovery of a new Cetacean, intermediate in character between the remarkable genera *Hyperoodon* and *Ziphius*. The new dolphin is to be called *Ziphiorhynchus cryptodon*.

An Italian frigate of war sailed shortly after Christmas last on an expedition to Siam and other countries, partly for the purpose of forming treaties of commerce, but also with the object of scientific discovery. The naturalists on board are Professor de Filippi of Turin and Dr. Henry Giglioli of Pisa, who was lately studying science in this country. The vessel has touched at Buenos Ayres and Monte Video, where the naturalists made some explorations into the interior and obtained several new species of birds and *Lepidoptera*. The pelagic animals obtained on the voyage were many of them new. The 'Magenta' is now on her way to Singapore.

Professor Agassiz is apparently meeting with great success in his expedition to the borders of the Amazon. He has more than tripled the number of species of fishes known in the Amazon and its tributaries. He has also discovered many new generic forms, and has established various remarkable physiological facts, such as the incubation of the eggs of several species of the family of the Chromidæ. In a letter from him, dated Ega (Amazons), 22nd September, 1865, he says:—"I have observed a species of *Geophagus*, which I have described under the name of *G. Pedroinus*, the male of which carries on its snout a very prominent knob, which is entirely wanting in the female and young. This same fish has a most extraordinary mode of reproduction. The eggs pass—I don't know how—*into the mouth*, the bottom of which they cover, between the internal appendages of the branchiæ, and especially in a pocket, formed by the superior pharyngians, which they completely fill. There they are hatched, and the young, free of their shell, continue to grow until they are in a fit state to take care of themselves. I don't know how long this takes, but I have already met with examples, in which the young were no longer provided with the vitelline sac."

M. Charles Robin, the distinguished physiologist, has been elected a Member of the Academy, in the section of Anatomy and Zoology, to supply the vacancy caused by the death of M. Valenciennes. The other candidate chosen for ballot was Dr. Lacaze Duthiers.

M. Aug. Dumeril lately communicated to the French Academy a note on the Lepidosirens (*Protopterus annectens* of Owen), which have been living in the Menagerie of the Museum of Natural History. Up to the present time, the only period at which the Lepidosiren had been observed was when it quitted the peculiar cocoon of mud—formed by itself—in which it was frequently brought to Europe from the Senegambia. M. Dumeril has had the opportunity of observing the animal form its cocoon, and by producing an artificial "drying up" of the aquarium in which the Lepidosirens were kept, has succeeded in imitating the conditions under which they are met with in the African rivers. He establishes the facts, that the cocoon is used as a protection under these circumstances, and is formed by a copious secretion of mucus from the surface of the body, and has no vegetable matters in it. The fish fed on earth-worms, and the peculiar cry, observed already by Mr. M'Donnell of Dublin, was uttered by one of the specimens at the Jardins des Plantes, when a portion of its cocoon had been broken.

The remarkable researches which have been going on during the last year in Germany, relative to the asexual reproduction of the larvæ of flies belonging to the genus *Cecidomyia*, are well worth the attention of all English naturalists; and it ought not to be long ere some of our own observers add their testimony to the evidence accumulated by our laborious continental friends. The first observations made on this subject were not published for some two years after they had been made, since the facts recorded by the naturalist who observed them appeared to the editors of the 'Zeitschrift fur Wissenschaftliche Zoologie' to be almost incredible. It was in the winter of 1861–1862, that Professor Wagner of Casan communicated to Von Siebold some very remarkable observations on the reproduction of certain insect larvæ. These larvæ he found in great numbers in the bark of a dead elm-tree, and observed that they were filled with other smaller larvæ, which completely resembled them. He at first thought this a case of parasitism; but afterwards came to the conclusion that he had here an instance of reproduction by insects which were themselves *larvæ*. Professor Wagner carefully followed up his first observations, and described in detail the larvæ and the perfect insect. This case of "alternation of generations," as it is called, Herr Wagner considered a simpler one than that of the Aphis. He compared it to the propagation of the Cestode and Trematode worms, basing his analogy on the fact that in the Dipterous larvæ he had not discovered special organs of reproduction. Professor Pagenstecher of Heidelberg then published some researches on the larvæ of an allied insect; he was able to confirm the general accuracy of Professor Wagner's conclusions, but differed from him with regard to the production of the germs and a few other details. The larvæ observed in this case were obtained in immense numbers from the refuse of some sugar works, associated with *Anguillula*, *Podura*, and other vermin. They belong to the genus *Sciara*, and it is worth noting that these observations were made at a distance of some 350 leagues from the locality of Professor Wagner's researches. Professor Pagenstecher described most minutely the anatomy of these larvæ. He differed from Professor Wagner as to the nature of the fatty bodies, and believed that the germs are formed independently of these bodies, but afterwards assimilate them as other nutritive matters. The exact position in which the eggs are developed he could not ascertain, but it appeared to be near the junction of the Malpighian vessels with the intestine. The gradual growth of the young larvæ inside its parent he most carefully describes, and it appears to moult while still in the egg; meanwhile the parent larva moves less and less, but still remains well and living, though largely distended. At length she assumes a new skin, which is harder and more chitinous than the last. The young, who have now escaped from their eggs, commence to devour her viscera, and at last finish by reducing their parent to the condition of a yellow larval skin filled with young grubs, which shortly escape. Professor Pagenstecher had no doubt that a complete analogy exists between this case of parthenogenesis and that of *Aphis*, and hence differed from Professor Wagner. On the 2nd of March last year a paper by M. Hanin of Charkow, on this same subject, was read at the Academy of Sciences of St. Petersburg. The larvæ he had studied were found under the planks of a house in the *débris* of various edibles. M. Hanin has verified Professor Pagenstecher's opinion that the ovules are produced by special organs; they are not simply developed in the corpus adiposum, but are produced in little sacs, to which he gives the name of ovaries. It must be remembered, at the same time, that these ovules or eggs are *pseudova*, and not true *ova*, as far as we know. M. Hanin's paper is especially valuable on this account, that he describes the development of the pseudova, and thus completes the history of this very remarkable case of agamic reproduction.

Dr. Lacaze-Duthiers describes a new and very remarkable genus of Ascidians in a late number of the 'Annales des Sciences Naturelles,' for which he proposes the name *Chevreulius*. There can be little doubt, as the author remarks, that this genus will form the type of a new group of Ascidia. It presents the very peculiar character of an Ascidian with a bivalve test, and hence offers an approach to the Brachiopoda in its external conformation; the lower valve being much the largest, and not differing much in appearance from that of some Thecidia. The minutest details of structure and life-history are given by M. Duthiers in this most elaborate essay on the genus. The chief point of interest in the little Chevreulius is the confirmation which it affords to the opinion of Messrs. Huxley and Hancock, that "the Ascidians, Brachiopods, and Polyzoa present a number of common characters." The indefatigable manner in which this naturalist is working is really such as to call forth some acknowledgment from us. During the past year he has published a very large number of most valuable papers and essays in both the 'Comptes Rendus' and the 'Annales.'

M. Balbiani records some very curious observations on the eggs of various Invertebrata, in the 'Comptes Rendus' for December. He states that he has observed canals traversing the substance of the vitellus, and in connection in some forms with the contractile vesicle which he discovered some time since. M. Balbiani's observations are so very remarkable that it is difficult to receive them with full assurance until they have been confirmed by other observers. He endeavours to point out that in ordinary animal cells there exists a contractile vesicle and canals connected with it, similar to the contractile vesicle and canals of the Infusoria. The author's observations were made principally on the eggs of *Geophile longicornis*, but also on those of the Dog, Ray, Batrachians, Annelids, Turbellarians, and Mollusca.

Phthiriasis and the *Pediculi* may not appear to be very inviting objects of study, but at the same time, it would have been expected that the anatomy of the Louse had been completely made out by the researches of some of our early microscopists. Leeuwenhoek, in 1694, remarked, "Præterea pro certo habentes adhuc millenas in capite pediculi esse res, quæ oculos nostros semper latebunt," and it appears that he was right; for, even with the microscopes of the present day, the mouth of the louse still remains a subject of discussion. The valuable series of papers of Dr. Leonard Landois, in Kölliker's 'Zeitschrift,' have brought the anatomy of these interesting parasites again before the notice of zoologists, and now we have a paper by Professor Schjödte, of great value, published in the Danish language, but happily translated by Mr. Dallas in the 'Annals of Natural History' for March. The earliest observers concurred in regarding the louse as a blood-sucking parasite, provided with a haustellum and not capable of inflicting a bite. Erichson, Simon, and Landois, however, contend that there exists a pair of horizontally working mandibles, true organs of biting, both in *P. capitis* and *P. vestimenti*, and in *Phthirius inguinalis*. Some cases of phthiriasis are brought forward by Dr. Landois in his papers to support this view. Professor Schjödte, however, attacks this opinion very vigorously, and points out that the three authors who support the biting theory have been misled by their method of examination, which has led them into discrepancies with regard to the existence of "hooks" or "palpi." Our author remarks that, according to these three authorities, we have a mouth consisting of the following parts:—(1) an haustellum, according to Erichson and Simon, provided with a pair of four-jointed palpi, but according to Landois, exhibiting a bifid labrum armed with hooks at one extremity, and reaching with the other far back into the head; (2) a pair of mandibles *underneath* the haustellum. This type of mouth differs fundamentally from that of all known arthropods; moreover, the so-called mandibles are totally devoid of muscles, and the pointed narrow form of the head in the louse is not such as to give support to biting organs. Professor Schjödte objects altogether to the mode of examination —that of cutting off the head and squeezing it flat on glass,—by which Landois and others have made their observations; for when the head is examined from beneath by reflected light without pressure, the so-called mandibles are seen to be *within* the skin, and, therefore certainly are *not* mandibles. He then describes how he observed the little lice, as did old Swammerdam, by letting them quietly feed on his own hand after keeping them hungry for a day or two, protruding their *haustella*, and sucking vigorously at the blood, while a pumping action was visible in the æsophagus, and the intestines worked with a regular peristaltic action. Lice are, according to our author, to be considered merely as bugs, modified to suit their position in life, their mouth being of the true Rhyncote type. Swammerdam, who wrote more than a century since, appears to have been almost exact in his description, and observed the small pumping ventricle at the base of the haustellum, which Schjödte again describes, whilst, with evident enthusiasm, he commends the writings of Swammerdam to his readers' study.

The microscopic examination of the fibres of meat cut from animals which had died of the cattle plague, has brought an interesting parasitic structure again before the notice of naturalists. In the ultimate fibres of the muscles of such animals, and also more rarely in healthy individuals, exceedingly minute, elongated, saccular bodies with granular contents, and a finely fringed envelope, are to be observed; and there has been much question as to whether these are entophytes or entozoa, or anything else. Meisner appears to have first described such bodies in 1839, having observed them in the muscles of a mouse. The best account of them, however, is that of Rainey, in the 'Philosophical Transactions of 1857,' who, though he mistook them for the young forms of cestoid entozoa, described them very accurately, and observed that they gave rise to smaller ovoid bodies, which he carefully figures. These observations were made in the pig. There can be little doubt that the parasites are *Gregarinæ*, and that the smaller ovoid bodies are their "psorosperms" or "pseudo-navicells," though Dr. Beale and Dr. Spencer Cobbold, who have lately been examining those from the cattle-plague meat, do not give a definite opinion. The most unpleasant part of the matter is, that we are all probably frequently eating these minute parasites without being aware of it; and may, perhaps, be unconsciously infested by them ourselves, since they do not produce any apparent symptoms in the animals in which they occur.

Zoological Society of London.—This Society has lately obtained one of the curious eared seals (Otaria) for its menagerie, probably an individual of the *Arctocephalus Hookeri* of Dr. Gray. It was brought from Cape Horn. Mr. T. Davidson, F.R.S., has communicated some notes to the Society on recent Brachiopoda dredged by the late Lucas Barrett off Jamaica. Five species were described in this paper, three of which were considered to be new to science.

Mr. Flower has read the first part of his memoir upon the osteology of the sperm whale (*Physeter*). Mr. Flower's observations were based principally upon a nearly perfect skeleton of this animal lately received by the Royal College of Surgeons from the coast of Tasmania, and upon a skeleton recently obtained by the British Museum from the north coast of Scotland. Other specimens in various European collections had also been consulted when available. In the present communication, Mr. Flower confined his remarks to the vertebral column of this huge animal, which was described in detail.

A communication has been made by Professor Baird, of the Smithsonian Institution, Washington, containing some notes on the habits of the American Prong-Buck (*Antilocapra Americana*) by Dr. C. A. Caufield, which had been addressed in a letter to Professor Baird, from Monterey County, California, in September, 1858. Dr. Caufield's notes tended to show that this animal sheds its horns periodically, and thus confirmed Mr. Bartlett's observations, made upon this animal from the example living in the Society's Gardens, which had been reported to the Society at one of their previous meetings.

Mr. P. L. Sclater has read a paper upon the genera and species of Caprimulgidæ belonging to the New World, commencing his communication by some preliminary remarks on the general arrangement of the whole family and its geographical distribution. Mr. Sclater proposed to divide the family Caprimulgidæ into three sub-families,—1. *Caprimulginæ*; 2. *Steatornithinæ*; 3. *Podarginæ*, —and showed that each of these groups possessed very distinct characters, which might almost entitle them to rank as three different families. As regards the American Caprimulgidæ, Mr. Sclater was acquainted with about forty well-distinguished species of this group belonging to the New World, amongst which was one from New Grenada, considered to be new to science and proposed to be called *Stenopsis ruficervix*.

Quarterly List of Publications received for Review.

1. The Treasury of Botany; a Popular Dictionary of the Vegetable Kingdom; with which is incorporated a Glossary of Botanical Terms. Edited by John Lindley, Ph.D., F.R.S., and Thomas Moore, F.L.S., assisted by Numerous Contributors. In Two Parts. With *Steel Plates and Wood-engravings.* 1270 pp. Fcap. 8vo. *Longmans & Co.*

2. On the Anatomy of Vertebrates. Vol. I.—Fishes and Reptiles. By Richard Owen, F.R.S., Superintendent of the Natural History Departments of the British Museum. 452 *Wood Engravings.* 690 pp. Demy 8vo. *Longmans & Co.*

3. Reliquiæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Perigord and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Part I., December, 1865. *Plates and Wood Engravings.* Royal 4to. *From the Executors of the late H. Christy, Esq.*

4. Pre-historic Remains of Caithness. By Samuel Laing, M P., F.G.S. With Notes of the Human Remains, by Thomas H. Huxley, F.R.S. *Plates and Wood Engravings.* 160 pp. Demy 8vo. *Williams & Norgate.*

5. The Year-Book of Pharmacy: a Practical Summary of Researches in Pharmacy, Materia Medica, and Pharmaceutical Chemistry during the year 1865. Edited by Charles H. Wood, F.C.S., and Charles Sharp. 175 pp. Crown 8vo. *John Churchill & Sons.*

6. The Geology and Scenery of the North of Scotland; being Two Lectures given at the Philosophical Institution, Edinburgh. By James Nicol, F.R.S.E., F.G.S., Professor of Natural History in the University of Aberdeen. 96 pp. Fcap. 8vo. *Oliver & Boyd.*

7. On the Nature, Cause, and Treatment of Tuberculosis. By Horace Dobell, M.D., Physician to the Royal Infirmary for Diseases of the Chest. 90 pp. Crown 8vo. *John Churchill & Sons.*

8. Guglielmo Rossi. Sulle Istituzioni di Istruzione primaria nella Lombardia, e in particolare nel Circondario di Monza. Allocuzione Storico-statistica. Seconda Edizione. 100 pp. 4to. *Milano : Pietro Agnelli.*

9. First List of Flowering Plants and Ferns found within four Miles of the Close, Rugby. By F. E. Kitchener, Assistant-Master, Rugby School. 16 pp. 8vo. *From the Author.*

10. A Dictionary of Science, Literature, and Art; comprising the Definitions and Derivations of the Scientific Terms in general use, together with the History and Descriptions of the Scientific Principles of nearly every Branch of Human Knowledge. Edited by W. T. Brande, D.C.L., F.R.S., and Rev. George W. Cox, M.A. Part VIII. *Longmans & Co.*

11. The Danger of Deterioration of Race from the too rapid Increase of Great Cities. By John Edward Morgan, M.A., M.D. Oxon., Physician to the Salford Hospital. 60 pp. Fcap. 8vo. *Longmans & Co.*

PAMPHLETS, PERIODICALS, PROCEEDINGS OF SOCIETIES, &c.

Geological Map of England and Wales. By Professor Ramsay, F.R.S. *Stanford.*

The Stars, in Twelve Maps on the Gnomonic Projection, collected, in duplicate, in four plates. By Richard A. Proctor, B.A. 4to. *Longmans & Co.*

Programme de la Société Batave de Philosophie Expérimentale de Rotterdam.

The Cry of the Dumb. 20 pp. Crown 8vo. *Nisbet & Co.*

The Action of Vegetable Fungi in the Production of Measles and allied Diseases. By Tilbury Fox, M.D., London. 8 pp. 8vo. *From the Author.*

The Nature of so-called Parasites of the Skin. Same Author.

Cholera Prospects. Compiled from Personal Observation in the East. Same Author. *Hardwicke.*

A Letter to the Provost of Oriel, on University Extension. By Charles Daubeny, M.D., F.R.S. *Parker.*

Notes on some Birds inhabiting the Southern Ocean. By F. W. Hutton. *Natural Hist. Society, Dublin.*

The Celebrated Theory of Parallels. By W. Matthew Ryan, Washington.

The Pestilence. Why Inflicted: Its Duration, and Desolating Character. By James Biden. 24 pp. Demy 8vo. *Gosport: J. P. Legg.*

Comparative Anthropology of England and Wales. By D. Mackintosh, F.G.S. *Trübner.*

Treason; or, the Image of the Beast. 28 pp. 12mo. *From the Author (U.S.A.)*

Reports on Petroleum as a Fuel. Experiments made at the Morgan Iron Works, New York.

Annual Report and Transactions of the Plymouth Institution, and Devon and Cornwall Natural History Society, 1864-5. 115 pp. Demy 8vo.

Bulletin Mensuel de la Société Impériale Zoologique d'Acclimatation. *Masson et Fils.*

Report on the Health of Liverpool. By W. S. Trench, M.D., Medical Officer of Health, Liverpool

Report of the same Officer; Presentment to the Grand Jury, 1865.

Westminster Review. *Trübner & Co.*

Ethnological Journal. *Same Publishers.*

Geological Magazine *Same Publishers.*

Scientific Review. *Cassell, Petter, & Galpin.*

The Canadian Naturalist and Geologist: with the Proceedings of the Natural History Society, Montreal. *Dawson Bros.*

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures, and Conditions of the Institution for the year 1863. *From the Institution.*

Proceedings (Volume of) of the Liverpool Literary and Philosophical Society.

Proceedings of the Manchester Literary and Philosophical Society. Photographic Section.

Proceedings of the Royal Society.
„ „ Royal Astronomical Society.
„ „ Royal Geographical Society.
„ „ Chemical Society.
„ „ Geological Society.
„ „ Zoological Society.

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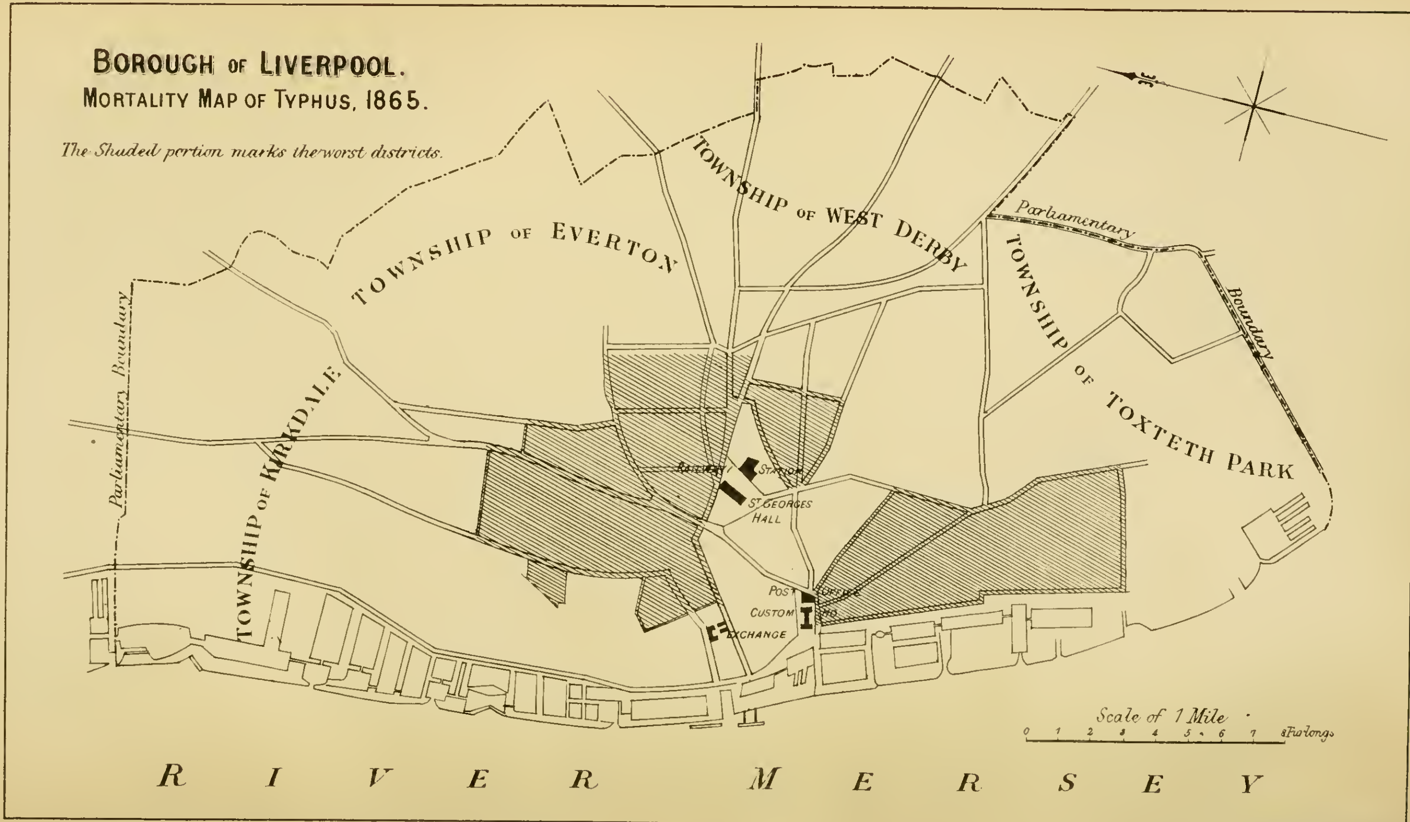


Copied in outline from the Map of the Medical Officer of Health

M & N Hanhart lith

THE QUARTERLY

JOURNAL OF SCIENCE.

JULY, 1866.

I. THE MORTALITY OF LIVERPOOL, AND ITS NATIONAL DANGER.

In the course of the last year this country has been visited by a cattle murrain, the history of which may be summed up in a few words. It came, we know not whence, although we are aware that such a plague exists in certain continental countries; it raged, and we know not what kind of disease it is, by what laws it is governed, or why it appeared in certain places, disappeared, and sometimes appeared again. We know that in some districts it was the most virulent where there was a want of cleanliness in the stalls, whilst many well-regulated farms escaped its ravages, and that is about all that science has reaped from the visitation. Every precaution was taken by the State to prevent its spread, and chiefly should those efforts have been successful in excluding it from Ireland; yet it appeared at length in that country also. The Clergy prayed for its removal, the nation (at least by deputy, through the State) humiliated itself for its sins, and probably in the due course of conventionality, the people will in a similar manner set apart a day for thanksgiving, when it has pleased Providence to allow this visitation entirely to pass away.

Whether the same invasion (if it be an invasion), the same destruction of live-stock, the same perplexity and the same religious processes will be repeated in another decade or so, remains to be seen, and will depend greatly upon the amount of improvement which takes place in the method of conducting farms, and the degree of application brought to bear upon the scientific question by veterinary surgeons, chemists, and physiologists. In the case of the cattle-murrain, the panic and helplessness of the nation has been to some extent justifiable, for our Statesmen knew nothing of the approaching danger, nothing of its nature when it came, and their professional advisers were in the same boat with themselves. But in the case of the human plague raging in the country, and recently aggravated by importations from abroad, there is no such excuse; and on this subject we now desire, while there is still time for warning, to address a word to the nation, and, not to the Government, but to the Representatives of the people.

In the House of Lords, on the 15th of May last, the Earl of Carnarvon "moved for Copies of Correspondence," in other words, sought information concerning the outbreak of cholera in Liverpool. He stated the fact, well known to their Lordships, that "a large number of German emigrants had landed at Hull, and had travelled by railway to Liverpool, and it was at Liverpool, without an exception, that all these cases had arisen. The most formidable outbreak had occurred on board a vessel that had sailed from Liverpool to New York. It was at Liverpool again, and among this body of emigrants that diarrhœa and typhus had been prevalent, and the House was aware that diarrhœa was the first stage, and, at all events, the harbinger of cholera. The habits of these emigrants were the reverse of clean, and they were congregated together in the most unhealthy quarters of the town. A case had been stated where 150 of these emigrants lived in one house in Liverpool, and forty in a single room. If these persons really came from cholera-infected countries, were these not all the conditions that would justify them in expecting cholera to break out?"*

Earl Granville, who, be it remembered, was at least the nominal head of the Committee which managed the cattle-plague, stated what steps had been taken to prevent the importation of cholera; observing that it would be impossible to enforce a system of quarantine in Great Britain, and remarking further, that a letter which had been issued by the Privy Council insisted upon sanitary regulations, "which really might be summed up in the terms fresh air and fresh water, and some of the outports really stood in urgent need of sanitary measures."†

In the House of Commons, the Right Honourable H. A. Bruce, the virtual head of the Cattle-plague Commissioners, gave the same information in reply to a similar question; and in the course of his remarks he observed that, "we were accustomed to think of cholera as marked by clear and unmistakable symptoms, and the stage of collapse was no doubt one about which there could be no mistake, but the earlier stages of the malady were not so easily discoverable. A person might have the disease lurking in his system for many days without suspecting it. He suffered but little pain, and the symptoms were such as persons often experienced without any interruption of their ordinary vocations. It would, therefore, be impossible, unless communication were absolutely forbidden between England and the infected countries, to expect that quarantine laws would prevent the introduction of the disease."

* 'Times,' May 15, 1866. † Ibid.

He stated further, that "he thought it would be better to leave the matter in the hands of the local authorities, as there was a general objection throughout the country to Government interference;" and also, that "the best security against the disease was for the local authorities to supply their towns with pure water, and to thoroughly clean and drain their houses."*

'The Times' newspaper reviewed the subject in a leader on the day when these remarks were reported in its columns, and thus disposed of the whole question:

"Better stop the imports" (of emigrants) "at Hull."

Before we state briefly to our readers what is known to science of the march of cholera, we will just extract from the preceding observations the opinions of the Legislature and of the Press on the subject:

1. They believe that it is impossible to enforce quarantine; and if it were, the disease is so capricious in making its appearence in individuals that it would be useless to do so.—In other words, *it is impossible to prevent the importation of cases of continental cholera.*

2. The local authorities object to Government interference; and it is for them, by the employment of sanitary measures, to render it innocuous when it touches our shores.

3. Nevertheless 'The Times,' which may be said on such a question to reflect public opinion, recommends the stoppage of the passenger traffic, and by that means the exclusion of the cholera.

From this summary our readers will be able to form their own opinion as to the amount and value of the advice and assistance likely to be afforded by the State in case of an outbreak of epidemic disease more virulent than that which already exists in the country!

Now it happens, fortunately for those who like to avail themselves of that channel for information, that Dr. Francis E. Anstie, the senior assistant-physician to the Westminster Hospital, has just published a most valuable little book on Epidemics, intended "for the use of the public,"† in which the whole question is concisely and ably reviewed, and we have marked the following observations for extract, as they will convey to our readers all that will be requisite for our consideration at the present time.

First, as regards *Typhus*:—

"Typhus first makes its 'nest,' to use a cant word which is dismally prevalent just now, in the courts and alleys inhabited by the very poor. Unlike relapsing fever, it is a very mortal disease; and, moreover, the contagion is much stronger than that of relapsing fever."‡

* 'Times,' May 15, 1866.

† 'Notes on Epidemics.' By F. E. Anstie, M.D., F.R.C.P. Jackson, Walford, & Hodder. 1866.

‡ Ibid., p. 44.

Again :—"If famine be the great predisposing cause of typhus, over-crowding is something more ; for there is much evidence to show that it can actually excite the disease in destitute persons. In regard to this, the various synonyms under which typhus has been described at different times are highly suggestive: the old terms—'jail distemper,' 'camp fever,' 'hospital fever,' and the like, point to instances in some of which, no doubt, the disease was only fostered by crowding and deficient ventilation, but in great numbers of which typhus was probably actually bred from the circumstances of the time and place."*

Secondly, concerning *Cholera* :—

"No doubt the disease is still an *opprobrium medicinæ*," (which we may venture to translate—Medical men know nothing of the nature of cholera ; and in a popular work such as Dr. Anstie's, they elect to acknowledge their ignorance in Latin!) "Yet something seems to have been learned, not merely guessed, about this mysterious pestilence in recent years."†

The following is amongst the information thus acquired :—

"'Neither climate, nor season, nor earth, nor ocean seem to have arrested its course, or to have altered its features. It was equally destructive at St. Petersburgh and Moscow as it was in India; as fierce and irresistible amongst the snows of Russia as in the sunburnt regions of India; as destructive in the vapoury districts of Burmah as in the parched provinces of Hindostan.' (Goodeve). . . . . 'The most that can be said is, that the places in which the air is most vitiated from drains, decaying animal matter, and vegetable refuse, or *overcrowding and concentration of human emanations*, are those in which cholera has generally been most fatal and most widely spread.' (Goodeve.)" ‡

"It is indisputable that cholera originates in places without its being possible to trace any previous communication with infected persons." . . . . "Either the outbreaks which occur in this remarkable way may be instances of the generation of cholera *de novo* from insanitary conditions, or we may suppose the poison to have been carried by currents of wind."§

The author shows that there is good reason for believing it to have arisen in this country from both causes ; but, says Dr. Anstie—

"*There can be no doubt that, in the majority of cases, the march of the disease follows closely the lines of most frequent human communication : thus it always appears first, in any country, at the sea-port towns, and these places form the first centres of infection.*"‖

He recommends not only that vestries should be empowered,

* Notes on Epidemics,' pp. 45–46.

† Ibid., p. 90.

‡ Ibid , pp. 94 and 95.

§ Ibid., p. 106.

‖ Ibid , p. 105.

but compelled, "*for they will never do it properly of their own accord,*" to see that a proper and copious water-supply is laid on to every house, and that typhus patients should be removed to fever-houses specially adapted for such cases.

Legislation and science, then, are unanimous in believing—

1. That it is impossible to prevent the inroads of cholera into this country from abroad.

2. That it is in sea-port towns where it first makes its appearance.

3. That cleanliness, and an ample supply of fresh air and clean water, are the conditions which render it innocuous when it touches our shores; and

4. That it is the duty of the Guardians of Health in the large towns to see that these conditions are observed, without the necessity for State interference.

Having laid down these propositions, which are unquestionable as far as they go, it now becomes our painful duty to point out, as we did on a previous occasion,* that the very conditions which are so favourable for the admission from abroad and forcing of epidemics at home, are to be met with in our large sea-ports, and, in fact, that some of those towns are in a state of chronic pestilence. And although the illustration which we mean to lay before our readers may by some be considered an exaggerated one (and we sincerely hope that it is so), we fear that it too faithfully represents the state of things in the Metropolis and in the large provincial towns.

We must admit, however, that the case of Liverpool is somewhat exceptional, for that important sea-port, whose traders are denominated "merchant princes," has merited the reputation of being the most sickly, and, harsh though the criticism may appear, the most squalid and sin-stricken of all our important boroughs. Of course these remarks do not refer to those parts of the town where the wealth of the inhabitants is earned. Those, it is true, are surrounded by a feeble cordon separating them from typhus and other diseases (resulting from over-crowding, drunkenness, and every other kind of vice) which may be snapped at any moment, permitting the passage of the plague; but those parts are at present tolerably exempt from disease. Nor do we refer to the suburbs where the "merchant princes" enjoy their repose after the toils of the day are over. Every one of course knows that the portions of Liverpool which are inhabited by the wealthier classes rise above the level of the lower parts of the borough, where the thousands of poor Irish and the hundreds of emigrants lie huddled together like sheep in a fold; and that the suburban houses are built upon sandstone-rock, and swept by the breezes of the Irish Sea. Of these again it

* "On the Predisposing Causes of Pestilence."—'Quarterly Journal of Science,' No. 7, July, 1865.

may be said, that of the shafts which are almost hourly aimed by Death into the nursery of fever below, a few fly too high, and reach the seats of affluence above.

Since the subject was last discussed in these pages, we have received at regular intervals the "Reports of the Health of Liverpool" drawn up by a gentleman who, to judge from the care and patience which he bestows upon that task, must be eminently adapted for his duties. Dr. Trench, the Medical Officer of the borough, seems to have made up his mind that we shall not lose sight of the important subject of which he treats, and if his Report, just issued, receives a more conspicuous notice at our hands than such parochial or corporate returns usually obtain, it is, as we have already stated, because the information which he so diligently supplies is of interest, not to his own town alone, but to the nation at large. We will let him speak for himself as much as possible, and his figures will be found stubborn and terrible facts.*

"The returns made by the local registrars record 19,374 births and 17,282 deaths in the Borough of Liverpool during the year 1865."

The births and deaths are pretty equally divided between the sexes. "The total death-rate of the borough was 36·4 per 1,000." The deaths were 446 in excess of those registered in the previous year, and 1,744 above the corrected averages of the last ten years.

In his statement which particularizes the causes of death (one of the many interesting tables accompanying his Report), we find that of these 17,282 deaths, 7,766, or nearly one-half, were children under five years of age; and we are told that "the truest test of the sickliness of a place is the average death-rate of children." Again, although the average rate of mortality for the whole borough is 36·4, that of the parish of Liverpool alone, in which 11,251 out of the 17,282 deaths occurred, was 41·5; whilst that of the "out-townships," which we have referred to as being the more healthy portions of the town, ranges from 19·9 to 38·9, making an average of 29·6. "In the year 1860," the Report says, "a year of great prosperity, the deaths only reached 11,236, making the death-rate of the borough as low as 26·0 in the 1,000, the lowest hitherto recorded."

Six years since, therefore, the death-rate was 26·0 in the 1,000 for the whole town. Last year it was 36·4 for the same; 41·5 for the borough, and 29·6 for the out-townships. This will show the reader what Liverpool is, and what it might be made.

Now let us look at the causes of death, and whichever way we turn we encounter the word "zymotic." The diseases embraced by

* 'Report of the Health of Liverpool during the year 1865.' By W. S. Trench, M.D., Medical Officer of Health for the Borough. Liverpool: Hewson and Procter.

this term are the contagious and epidemic disorders—Typhus, Diarrhœa, Small-pox, &c.; and we are startled by the announcement that of the 17,282 deaths registered in 1865, 5,526 (or nearly one-third) are known to have resulted from zymotic diseases; and of these 2,338 were "typhus and infantile fever;" and 1,016 from diarrhœa—the diseases which press closely in the wake of drunkenness, debauchery (and that cause of both, overcrowding), as vultures follow the rear of a great demoralized army.

Dr. Trench has been so diligent as to make up corrected averages of the last ten years, that is, he has corrected those averages to the population of 1865, "so that the figures at once show the comparative deaths to population," and he has compared the deaths in 1865 with the average mortality of the past ten years.

Here is the result, fearful in the present, ominous for the future, not of Liverpool alone but unless some sharp remedy be applied of the whole country.

The total deaths in 1865	17,282
Corrected average of the last ten years	15,538
Total deaths from zymotic diseases in 1865	5,526
From the same diseases in 1864	4,870
Average deaths from the same during the last ten years	4,062

In other words, 656 persons died in Liverpool of contagious and epidemic diseases last year above the number who died of the same disorders in 1864; and 1,414 more than the average of the last ten years. Is there not in our land a gradually increasing, not a mere passing plague, more immediately dangerous to the locality in which it is being forced, but at the same time threatening to the whole community? If any one doubts this, let him study the growth of the pestilence in Liverpool, and he will find that it has been gradually spreading its ravages and widening the sphere of its cankerous influences In some portions of the town, however, its effect has become so intensified that the medical officer feels himself warranted in regarding and specifying them as "the fever districts of the borough;" and if our readers will turn to the outline which we have sketched from the mortality map of the town that accompanies his report, they will perceive how large a proportion of the whole area of the Parliamentary borough is embraced by these infected localities. The three shaded patches are the "Fever districts." Lying midway between them is that portion of the town in which the trade of the port is conducted, and where its finest shop-streets are situated. Interspersed amongst these plague-patches are the noblest buildings in the borough; the Exchange and Town Hall, St. George's Hall, the Railway Stations, and nearly all the other buildings of note, such as the market halls, &c. The uncoloured portions beyond are on a higher level, Everton being probably the highest, but almost up to the very brow of the hill, the fiend "Fever" has made his home.

In the original map Dr. Trench has shown with red spots the number of deaths from typhus which occurred in the respective streets, and the mortality in some of them is positively frightful. If on some ball or festival night the roofs could be lifted from the houses in the fever-stricken districts, and the gay revellers hoisted, "*au diable boiteux*," to the top of the Town Hall, and provided with opera-glasses for the inspection of the interiors around them, we suspect they would go home sadder and wiser men and women, and would seriously consider the best method of bringing about in their city the much-talked of, but little practised, "Sanitary reform!"

We should have been glad to find in Dr. Trench's report a brief account of the number of cases of fever which have ended fatally as compared with those which have been successfully treated, and a comparison with former years. No doubt it would be difficult to draw up such a table, which would convey some idea of the efficiency with which the medical men had performed their duties and the increasing or diminishing curability of those diseases. To their causes we have already referred, cursorily here, and at length in our former article. *Overcrowding* with its concomitants, *drunkenness*, *immorality*, and *poverty*, these form the text from which sermons are preached daily in Liverpool, but preached in vain.

But there is one feature in this sad history which more especially merits the attention of our legislators and philanthropists. We will allow the able author whose report lies before us to describe it in his own terms:—

"It is this mysterious selection of its most numerous victims from among those who are the parents and the bread-winners of families that constitutes the dreaded attribute of typhus; for their death not only brings sorrow and grief to the survivors, but spreads want and pauperism over a wide radius of the social circle. This peculiarity is aggravated in its effects by another singular feature of typhus fever. It is essentially a disease of the poor, and is as a rule confined to them, or to those of the better ranks, who, as clergymen, district visitors, physicians, and nurses, work in the dwellings of poverty, or to those who, as victuallers, undertakers, pawnbrokers, and small shopkeepers, are brought by business into direct communication with the affected. Of the whole 2,338 deaths, no less than 2,177 were of persons from the class which live by weekly wages. Of the remaining 161, eighty-nine were tradesmen, and sixty-three either the widows or members of the families of tradesmen; nine belonged to the class of the gentry or professions. Among the tradesmen were twenty-six licensed victuallers, besides twelve members of their families. Of the other tradesmen, twenty (*viz.* three milk-dealers, two butchers, eleven flour and provision dealers and four grocers) dealt in comestibles, and were likely to have come in frequent contact with fever patients or with persons directly from the sick-room; twelve (*viz.* a druggist, four Scripture readers and pupil teachers, two relieving officers, two undertakers, a pawnbroker, a furniture broker, and a burial-club collector) were probably brought by business directly into the infected room, or became possessed of the infected bed, bedding, and clothes of the sick. Among the professions were two doctors. The families of tradesmen seem also to have suffered, in proportion to the risks incurred, from infection; for next to publicans, the most numerous victims were the relatives of provision dealers."

In addition to the clear and business-like account of the state of disease and the ravages of death in 1865 (for it is a mockery to call it a "Report of the *Health* of Liverpool") the medical officer has appended diagrams exhibiting the comparative mortality for the last three years, of that which occurs at the various periods of life, and much other valuable information deserving the notice of those interested in the health of large towns. But unfortunately we are not permitted to stop here, and to say that in the year 1865 such was the state of sanitary affairs in Liverpool.

For the week ending March 17, 1866, about two months before the outbreak or importation of cholera into the borough, the following were the rates of mortality in the various large towns of Great Britain:—

Newcastle	26	per 1,000
London, Salford, and Birmingham	30	,,
Dublin	31	,,
Hull	34	,,
Glasgow	35	,,
Sheffield	37	,,
Edinburgh and Leeds	38	,,
Manchester	39	,,
Bristol	40	,,
Liverpool	57 !	,,

Now we think we shall have carried our readers with us to the conclusion, that Liverpool, the greatest artery of emigration, and the port into which substances are largely imported which are the best calculated to convey the germs of disease (rags picked up in the streets of the large towns of Egypt and other Eastern countries, and cotton and wool from all parts of the world), is in the state best fitted to receive, fertilize, and disseminate those germs; and it remains for us to inquire in what manner the local authorities of that important borough acquit themselves of the duty they owe to its inhabitants and to the nation.

The guardians of the public health in Liverpool are, or should be, the Town Council, and more immediately the Health Committee of that council, a body consisting of a number of well-meaning, kind-hearted gentlemen, who would, if they knew how, bring about a better state of things than now exists in the borough. The health officers are Dr. Trench the medical officer, Mr. Newlands the borough engineer, and until lately, Mr. McGowen, the deputy town clerk and the legal adviser to the Health Committee, now town clerk of Bradford. Upon these gentlemen, than whom a more enthusiastic, honest, and indefatigable trio never existed, devolved the responsibility of pulling down and improving houses unfit for habitation with the disagreeable accompaniment of turning out the tenants inhabiting them. The difficulty which they encountered in obtaining magisterial support was referred to in our former article as characteristic of the state of things in every part of the country; but now let us see how their efforts were seconded by the Council itself—for, not having any concern with local politics, we have only to deal with the Corporation as a body, and not with any of its committees or sub-committees.

About the time of the cholera outbreak, the following, as nearly as we can ascertain, was the state of affairs. To the *credit* of the corporation in the alleviation of the plague-stricken districts, we find the following items, approximately stated, but sufficiently so for practical purposes.

Since the passing of the Sanitary Amendment Act of 1864, three presentments had been made by the Grand Jury to demolish in all 485 houses. The amount which had been expended for that object was about 4,000*l.*, and it was expected that about 30,000*l.* more would be employed for the purpose.

An active member of the Health Committee brought forward a motion that 1,000*l.* should be granted for structural alterations in courts, to give them more light and air, but it was not carried (our readers may think this should go to the *debit* of the account). Small sums, however, varying from 15*l.* to 40*l.*, are occasionally voted out of "surplus capital" for the purpose.

The corporation has bought, with a view to re-sale on chief rent, for the purpose of building workmen's dwellings, 22,550 yards of land at 18*s.* per yard.

We think these are the important items, making in all, let us say, 60,000*l.* or 70,000*l.* to the credit of the local authorities of Liverpool, for what we shall call the "Reformation Account." Now let us inquire what goes to their debit in money and kind; that is to say, what money has been devoted to less necessary purposes, and what steps have been taken to *retard* sanitary progress there.

In the first place, for the benefit of the large shopkeepers and the local gentry the small item of 118,000*l.* (we are within 1,000*l.* of the mark, and *under* it) has been devoted to widening a portion of Church Street, already one of the handsomest streets in the town: of this amount 8,000*l.* was employed in law expenses.

Item No. 2 is a trifle of 250,000*l.* for a "People's Park," situated about five or six miles away from those parts of the town of which the inhabitants have most need of fresh air. Although this project was brought forward ostensibly for the benefit of the "people," it was stated at the time in the Council by a member of the Health Committee (that committee, we believe, having opposed the scheme), that it was in reality a park for the gentry, and something was said to the effect that it was intended as a kind of barrier between the poor and rich. A member of the council, a draper, who advocated the project very warmly, and who, we believe, inhabits a handsome house beyond the boundary of the intended Park, said something about the necessity of a "Rotten Row" for Liverpool, where the poor would have the pleasure of seeing the equipages and attire of the rich. About the same time a discussion took place concerning the short water-supply of the town, and the chairman of the Water Committee said regarding the Corporation Baths for the poor, "that the town could not afford water for such luxuries!" Here, then, we have two items of 368,000*l.* for widening a wide street in the town and forming a Park outside of it. And it has been stated in defence of this latter proceeding, that a good deal, if not all the "Park-money" may be recovered if properly dealt with. Just as if the same rule would not apply much more forcibly if the same money had been laid out in sanitary improvements within the borough.

But, about the time stated, the Town Council committed an act in direct opposition to the wishes of the community, as expressed in strong terms by nearly all the local papers, of whatever creed or politics, which cannot be too severely reprobated, and of which we can hardly think some of the persons concerned had seriously weighed the consequences. They virtually drove away from the town the gentleman who was not only the most willing but also the most able to deal with the great danger which has been hanging over the town so long and which threatens the country at large, we mean Mr. McGowen, the legal adviser to the Board of Health and Deputy Town Clerk.

As far as we can gather from the local press, and from reliable information which we have received, the circumstances of this proceeding were as follows :—

The Town Clerk, Mr. Shuttleworth, was compelled by indisposition to retire from his office, and amongst the local applicants was naturally Mr. McGowen, his Deputy, who had been twelve years in the service of the Corporation; of the Health Committee more particularly, and in whose favour all the local candidates withdrew. Mr. Rayner, the Town Clerk of Bradford, was the only other competitor, and when he heard how strong a feeling had been manifested in favour of Mr. McGowen he also withdrew. A powerful cabal was however formed, consisting of some leading men "on both sides of the house" (for, as we hear, party politics run tolerably high in the Liverpool Town Council), and these persons succeeded in inducing Mr. Rayner to renew his application, and under a promise that a separate office should be created for Mr. McGowen, they also induced a small majority of the council to elect their nominee, contrary to the wishes of the Health Committee, who pleaded hard for their best coadjutor, and also against the voice of the large mass of the townspeople. Shortly afterwards, Mr. McGowen was offered the Town Clerkship of Bradford, and seeing, as he said, that there was no intention to provide him with an office, he accepted it. Then followed laudation and regrets, a corporate testimonial, and after his departure (if we are rightly informed) still greater perplexity in regard to the health of the town, for immediately afterwards the cholera outbreak occurred. Many were the rumours at the time concerning the motive which induced a number of gentlemen to propose, and others to countenance this suicidal conduct. Personal animosity and cliqueism were the more generally credited causes, but it was even rumoured that the exigencies of party politics of a wider (we cannot say *higher*) nature than mere local ones had necessitated the act. Be that as it may, our readers will agree with us that it is little to the credit of the Corporation of Liverpool, and that it is a national hardship that the town and kingdom should thus be further exposed to the ravages of a virulent epidemic. To repeat the printed words of Dr. Duncan, when speaking in 1843 of the state of things which had existed in Liverpool for half-a-century, and throughout that time had rendered it, as it is to-day, the most unhealthy town in the whole country, "*inferior considerations triumphed over the public good.*"

Is it necessary that we should recapitulate the conditions which, it is agreed on all sides, are absolutely requisite for the safety of the three kingdoms, in order to show that none of those conditions are complied with in a most vital portion of the realm? Are our readers satisfied that epidemics rage in an unnecessary degree in the great aorta of our commerce and emigration—that every condition exists there for fostering those diseases, and that the local governing body should not be permitted any longer to administer this portion of its duties without higher direction and control?

We cannot think this requires any further showing. What, then, should be done? Shall Government interfere? We should say not. The Chancellor of the Exchequer, being member for that division of the County of Lancaster in which Liverpool is situated, and having a near relative in the Town Council, might be subjected to the same influences which are brought to bear upon the local members, and which impede the progress of sanitary reform. We do not for a moment mean to insinuate that the Right Honourable gentleman would be guided by such influences any more than we should suppose the members of any honourable body would knowingly allow themselves to be thus led or coerced. But occult influences are so easily brought to bear in all these matters, that it is better for local reforms to be enforced by strangers than by friends. A special Committee of the House of Commons on the whole question of the health of our large towns would of course be the alternative (and the only one, as far as we can see), and such a commission would no doubt first direct its attention to the most sickly towns—Liverpool being notoriously *the* worst. In its labours it would no doubt have the cordial co-operation of the honourable members for the borough and county, two of whom, by the way, Mr. Graves and Mr. Charles Turner, are members of the Liverpool Town Council.

Having thus explicitly, and we trust charitably, made public the sanitary state of Liverpool, its dangers to the country, and the remedy which appears to us to be the most feasible, we must defer the consideration of the health of other large towns for the present, and leave the matter in the hands of those whose duty and interest it is to watch over the public safety, and to prevent amongst our people an outbreak of pestilence similar to that which has ravaged our herds and flocks.*

II. THE NEW IRON-FIELDS OF ENGLAND.

By Edward Hull, B.A., F.G.S., of the Geological Survey of Great Britain.

It is now becoming daily more apparent that there is scarcely a geological formation—at least in England—which cannot be turned to some economic use, or is incapable of yelding some mineral substance of value to man. Whether the formation be granite, porphyry, slate, grit, sandstone, limestone, chalk, clay, or shale, all are included under the above category. The requirements of art and the progress of civilization put the earth under tribute, and however often the levy is made, the supply is certain to be ready: on the other hand, the very variety of the mineral products constantly challenge

* Since the above article was written, the Corporation of Liverpool have applied to Parliament for powers to obtain an increased water-supply. The following is the evidence of Dr. William Stewart Trench, examined by Mr. Milward: "I am Superintendent of the Board of Health at Liverpool. The death-rate last year was 36·4. The average throughout the kingdom is 22. The average death-rate in towns is 24·1. *If Liverpool had been as healthy as the average of towns, we should have saved* 6,000 *lives.* Last year, I brought the subject before the Health Committee, and they submitted it to the Water Committee. There is a painful want of water in Liverpool. The state of health in Liverpool in May and June was very bad, and when diarrhœa appeared the death-rate was considerably increased—very much owing to the inadequacy of the rainfall and the supply of water. There was a direct connection between the death-rate and the insufficient water-supply. *I look with great anxiety to the threatened approach of cholera, and particularly to what may occur during the months of July, August, September, and October.*"

man's inventive powers to find out their uses, and in this way, more perhaps than in any other, nature is the instructor of art.

It is an old remark, that the most useful of all our metals is the most abundantly diffused through the rocks and strata of our earth. In some parts of the world nearly pure ores of iron occur in masses of sufficient magnitude to constitute hills, or parts of mountains. This is the case in Scandinavia, parts of Central Europe, and Southern India, where magnetite assumes the proportions rather of a rock than of an ore.* In our own country, however, we have no such examples of the massive accumulation of pure iron-ore, but the difficiency is amply compensated for by the frequency of its occurrence in combination with other substances. Before entering more fully on this subject, I wish to make one or two remarks on a point of nomenclature, which it would be of advantage to adopt when speaking of the different forms in which iron-ores occur. The classification of these ores into two groups, to be called "iron-ores" (proper) and "iron-stones" respectively, will be easily apprehended by all persons familiar with the manufacture of iron; and the various modes of its occurrence. The distinction holds good for the most part, both mineralogically and stratigraphically, and is indeed often unconsciously used in commerce. Under the head of "iron-ores" (proper) might be classed those which occur either in the form of veins or lodes, and pockets, such as the red hæmatites of North Lancashire, Cumberland, and the Mendip Hills, the brown hæmatites of the Forest of Dean, South Wales, and Cornwall, and the magnetite of Cornwall, Devonshire, and Sweden. Now all these ores are amongst the richest in iron, are but slightly debased by any foreign substances, and they occur in the form of the ores of other metals, such as copper and lead, or approximately so. The "iron-stones," on the other hand, are of a more earthy character, are consequently not so rich, and partake more or less of the laminated or bedded structure of the strata with which they are associated. Under this head may be classed the black bands and clay-iron-stones of the coal-measures, the iron-bearing beds of the Lias, Oolite, Greensand, and Wealden formations. There are, doubtless, some rare cases in which the ores partake of an intermediate character, but in the great majority of cases they may be arranged under one or other of these heads.

The ores which we are about to consider are of the latter description. They are essentially *iron-stones*, and occur, to a greater or less degree, in a stratified form, partaking of the aqueous origin of their associated rocks. So similar indeed are they to ordinary strata, and so little calculated to arrest attention, that for hundreds of years they had been quarried for building purposes, or even for-

* See the description of the Magnetic Iron-ore of the districts of Trichinopoly, Salem, and South Arcot, in this Journal, No. VI., p. 342.

the less honourable use of mending roads, without their metalliferous qualities having been discovered.

I may here be allowed to capitulate very briefly the progress of the iron-smelting of this country to the present time. The sources from which our chief supply of iron had been procured from very early periods down to the middle of the last century were the hæmatites of Gloucestershire, South Wales, the Mendip Hills, and the iron-stones of Kent and the Weald of Sussex; the coal-measures of Salop, Lancashire, Yorkshire, and Scotland. Some of these ores are believed on good grounds to have been worked by the Romans, the fuel generally, but perhaps not exclusively, used in the process of smelting being charcoal. This material, however, became gradually scarce, and some of the writers of the last century lament the rapid destruction of the forests both of the South of England and the Midland counties, owing to the using up of the trees.* Necessity is the mother of invention, and as the requirements of iron became more extended, and the supply of charcoal diminished, it became necessary to try some other fuel. There is, as is common in such cases, some uncertainty to whom the honour belongs of having first successfully employed coal for this purpose, but it is generally admitted that Dud Dudley, after several failures, was the first to succeed in the attempt. The wasteful consumption of this valuable mineral in the process of smelting was at first enormous, but as the process began to be more generally adopted, as improvements took place in the formation of the furnaces, the use of the hot blast and other appliances were introduced, the proportion of coal employed became gradually less, down to the present day, when it may be said to have nearly reached its minimum.

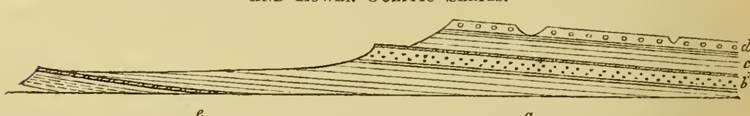
The black-band and clay-band iron-stones of the coal-measures have hitherto been our chief sources of supply. These ores occur in thin layers associated with coal-seams, shales, clays, and sandstones. A few years since, however, the rich hæmatites of North Lancashire and West Cumberland were opened up, and are now very largely used, both for mixing with the former and for the manufacture of the finest pig-iron directly from the ores themselves. From this iron only Bessemer steel is at present made. The ore occurs in enormous "pockets," or irregular masses, filling chambers in the carboniferous limestone, and often only covered by a few feet of drift clay or millstone grit, while in one or two places it is quarried in open-work. Meanwhile, the process of exhaustion of the coal-measure iron-stones in some of the principal centres of manufacture was going on apace, and it must be confessed that now the *local* resources of Staffordshire, Shropshire (Coalbrook Dale), and the

* I am informed by Mr. W. Brockbank that there are still two or three places in Great Britain where charcoal is used in smelting under peculiar circumstances, and for the production of a very high class of pig-iron.

Glasgow districts are rapidly diminishing, while every year the demand for iron is increasing. How this demand was to be met, without drawing largely on the resources of foreign countries, is a problem which received its solution just at the time when it began to occupy men's minds. The solution was the discovery of those "New Iron-fields of England" which occupy a broad belt of country traversing our island almost from the shores of the English Channel to those of the German Ocean.

This belt is formed of a range of hills with scarped ridges, and longitudinal valleys, rising to the eastward above the plains of the central counties. In this range are included *geologically* the Cleveland Hills of Yorkshire and the Cotteswold Hills of Gloucester and Somerset; but it must not be supposed that the strata are equally rich in iron all along the entire range, although the representative formations in which the iron occurs may be present throughout. This range at several points both in Yorkshire and Gloucestershire reaches elevations exceeding one thousand feet above the sea, and terminates in the coast-cliffs of Saltburn on the north, and those of Lyme Regis on the south. It is composed of Jurassic formations,* or speaking more definitely, the upper members of the Lias and the lower members of the Oolite series. From the base of the range the Lower Lias and New Red Marl stretch away in slightly undulating plains towards the west, and with some slight modifications the general succession of the strata, and the form of the hills as they occur in Yorkshire, Lincolnshire, Gloucestershire, and Somersetshire, may be expressed as in the following diagramatic section.†

FIG. 1.—DIAGRAMATIC SECTION, TO ILLUSTRATE THE POSITION OF THE LIASSIC AND LOWER OOLITIC SERIES.



Red Marl. (*a*) Lower Lias. (*d*) Lower Oolite.
(*b*) Middle Lias or Marlstone; the dark band represents the Ironstone.
(*c*) Upper Lias. (*e*) Lias Limestone.

There are two positions in the above section where the ironstones occur, the lower being at the top of the Middle Lias, or Marlstone, the upper at the base of the Great Oolite. This latter, however, is almost exclusively confined to Northamptonshire, and by far the most important member is the Middle Lias iron-stone of the counties of York, Lincoln, and Oxford. The range also touches the counties of Rutland, Leicester, and Warwick, in all of which

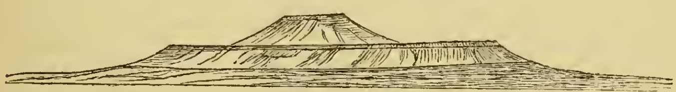
* "Jurassic"—a good term—taken from the Jura range on the borders of France and Switzerland, whereby to include the Liassic and Oolitic formations under one name.

† The main difference is, that in Yorkshire the Great Oolite rests on the Upper Lias, in Gloucestershire it is replaced by the Inferior Oolite.

iron-stone occurs, but it is as yet unrecognized, practically at least, in the Coteswold Hills and in Somersetshire.

The iron-stone is the upper member of the Marlstone, or Middle Lias formation, the lower consisting of sandy shales, or fine laminated sands with bands or nodules of iron-stone. Where the upper member ceases to be sufficiently rich in iron to be deemed an iron-stone, it occurs in the form of a hard calcareous grit, generally very full of its characteristic fossils, such as: *Rhynchonella tetrahedra*, *R. variabilis*, *Terebratula punctata*, *Pecten æquivalvis*, *Nautilus truncatus*, *Ammonites margaritatus*, and *A. spinatus*. As it is overlain directly by the soft shales of the Upper Lias (or "alum shale"), these in the process of denudation have often been washed away, leaving platforms of the rock projecting from the flanks of the range, or forming isolated flat-topped hills rising above the general surface of the country. Oxenton Hill in Gloucestershire is a good illustration of the latter case; and the section above (Fig. 1) represents the former.

FIG. 2—A GLOUCESTERSHIRE HILL.



In the above figure the upper conical portion of the hill is composed of Upper Lias, capped by Oolite, the platform on which it rests being Marlstone, or Middle Lias.

The oolitic iron-stone of Northamptonshire, and a few other places, belongs to the lower portion of the Great Oolite, called by the Geologists of the Government Survey "the Northampton Sands,"* and is very irregular in its distribution, although occupying on the whole a large tract of country. These sands rest directly on the Upper Lias Clay, and are overlaid by the white limestones which form the upper member of the Great Oolite. The iron-stone is found in irregular beds, sometimes reaching a thickness of twelve or fourteen feet, and within a mile or two thinning away altogether. There is a remarkable instance of this near Blisworth, for the iron-stone, which occurs plentifully at the northern side of the railway tunnel, disappears altogether at the southern end. The ore is a hydrated oxide of a rich rusty-brown colour, of high specific gravity, and silicious. When reached at some distance underground, where it has been protected from atmospheric influences, the colour is found to be olive-green, but these portions are generally rejected by the quarrymen. It is extensively worked at Blisworth, Gayton, Glendon, Maidford, Wellingborough, and Duston. In all, there are about thirteen quarries and four furnaces in blast in Northamptonshire, besides which, large quantities of the stone are sent by

* See memoirs 'On the Geology of Parts of Northamptonshire,' by Mr. W. T. Aveline, F.G.S.

canal and rail into South Staffordshire, and even South Wales. The quantity of ore raised in 1864 was 335,787 tons, of the value of 84,761*l*. The furnaces are situated at Wellingborough and Weedon.

Having thus described the geological position of both the Oolitic and Liassic iron-stones, and also the special characters and districts where the former of these occurs, we shall now return to the consideration of the latter and more important source of supply from the New Iron-fields, and trace its course from Yorkshire in the north to Oxfordshire in the south.

The Cleveland Hills, the cradle of the new iron trade, form a range of very picturesque hills, terminating northward in a line of escarpment, ranging along the valley of the Tees and in lofty cliffs lining the coast of the German Ocean from Saltburn to Whitby. Inland, the escarpment bends round to the southward, opposite Middlesborough, and stretches in an indented line to the banks of the Humber, near Hull. The northern portion of the hills is intersected by deep valleys, some entering from the coast, as those of Skelton Beck, Kilton Brook, Easington, and Rondsley Brooks. Others enter from the land side, as those of Guisborough and Kildale. The summits of the ridges between these valleys are capped by Great Oolite, below which is the Upper Lias shale, forming the upper slopes down to the Marlstone, or iron-stone bed, which juts out along the flanks of the valleys about half-way from the bottom. The importance of these valleys in laying bare the outcrop of the iron-stone, and allowing it to be extensively worked without the labour and cost of mining, will be readily appreciated. Already, numerous tramways and branch lines connecting the mines with the North Yorkshire, Cleveland, and Stockton and Darlington Railways, as well as with special smelting-furnaces, have been constructed. Like the Cotteswold Hills, in Gloucestershire, the Cleveland Hills may be regarded as an elevated table-land, so deeply indented and cut up by valleys, that its original form is almost obliterated, and it now presents the appearance of an assemblage of ridges and ramifying valleys, with little appearance of order or system in their arrangement. This, however, is only apparent, as the upper surface of the ridges corresponds to an imaginary plane sloping gently towards the south-east. The general vertical section of the formations as they occur near Saltburn is as follows:—

		Thickness in Feet.
Great Oolite . . .	Yellowish sandy Oolitic Freestone . .	30
Upper Lias . . .	Dark blue bituminous Shales . .	150
Middle Lias, or Marlstone	1. Nodular Iron-stone, with a thin band of Iron Pyrites	3 in.
	2. Solid greyish-green Iron-stone . .	12 ft.
	3. Sandy and rusty Shales . . .	12
	4. Second bed of Iron-stone, resembling "clay-band," with 30 per cent. of Iron	3
	5. Sandy Shales and Sandstone . .	80
Lower Lias . . .	Blue Shales and Clay	—

The upper bed of iron-stone is alone worked, and this is done either by mining from adits driven into the sides of the hills, or by open-work, as at Hob Hill Quarries. It is of a greyish-green colour, finely oolitic in structure, and weathers into rusty concretionary bands and nodules. Some of the mines are on a very extensive scale. At Eston and Up-Leatham mines, the iron-stone rock dips into the hill from the outcrop at 1 in 15, becomes horizontal under the central part, and rises again to its outcrop at a distance of several miles to the southward in the valley of Guisborough. The mode of working is by galleries six yards wide, walls being left of equal width to support the roof, until the whole of the property is opened up, when these will be recovered by working backwards. A thorough system of drainage and ventilation is established, and the stone is drawn up in trucks to the mouth of the adits by stationary engines, and tipped over into the wagons of the Stockton and Darlington Railway, in which it is carried direct to the furnaces. In general, it is considered that three tons of the raw ore produce one ton of pig-iron.

The following are the proportions of fuel, flux, and stone in use at the works of Mr. B. Samuelson, M.P., in 1864, since which time the proportions of fuel have been considerably reduced:—

3 tons of raw ore, or 2 tons 8 cwts. calcined ore	one ton of grey forge pig.
24 cwt. coke	
12 cwt. limestone	

The banks of the Tees, which are nearly flat for some distance from the river, and then rise with a gradually-increasing slope to the base of the Cleveland Hills, form an admirable site for the erection of smelting works and forges on the largest scale. Along the southern shore the Stockton and Darlington Railway has been carried to Saltburn, and in one direction serves to supply the ore, and in the other the fuel from the Durham coal-field. No one can drive along this line from Redcar to Stockton, and pass in succession the Titanic works which have been erected and are still rising along its course, without being impressed with the prodigious energy displayed by the iron-masters of this district; for it is to be remembered that the whole of these works have sprung into existence within the last sixteen years. Middlesborough is the metropolis of this trade, and the chief port for the shipment of the iron, both in its raw and manufactured states. Other smelting and manufacturing works are also erected on the northern shore of the Tees, and in 1865 the whole district comprised 105 furnaces in blast, smelting very nearly one million tons of pig-iron.

The Cleveland iron-stone becomes thinner, and is leaner towards the south, but as the quality of the iron is good, it is extensively worked in the valley of the Esk, near Whitby, the new line from

Picton to Whitby giving access to the Durham coal-field. The stone is also largely worked along the sea coast from Whitby to Redcar, and is shipped chiefly to the iron-works on the Tyne.

The Rosedale iron-stone is the richest of all the Cleveland ores. Its colour is dark olive-green, it has a high specific gravity, is compact, magnetic, and polar. It contains from 35·94 to 49·17 per cent. of metallic iron, and is smelted by itself at Ferry Hill, but is chiefly used for mixing with the other ore in the Cleveland furnaces. In 1864, nearly 300,000 tons were quarried and carried to market by a special branch railway. Continuing the survey southward, we find the iron-stone of the Lias cropping out in the direction of Northallerton and Thirsk, and trending thence in a south-easterly course by Easingwold, Hulton, and Market Weighton to the Humber. The dip is here a little north of east, and there are extensive tracts where it has not as yet been opened out.

On crossing the Humber and entering Lincolnshire, we again get on the track of the same bed at Saint Hope and Frodingham, in the northern part of the county, and from thence we can trace it southwards along a low range of hills rising to the eastward of the valley of the Trent. At the Frodingham iron-furnaces, built on the outcrop of the iron-stone, which is here twelve feet thick, there is a very fine section in the railway cutting, which fully exposes the relations of the iron-stone to the underlying Lias. At the Trent Iron-works there are three furnaces, and here the rock is actually twenty-nine feet in thickness! Further south, where the North Lincolnshire Company are erecting two very large furnaces, the rock is of similar thickness.

The mode of working in this district is very simple, and has been described to the writer by Mr. W. Brockbank, F.G.S., as follows:—As the iron-stone lies exposed on the upper surface of the hills, the furnaces are erected upon it as a foundation, and the inclines for raising the minerals to the tops of the furnace are carried down to the base of the iron-stone, where the wagons are filled and hoisted directly to the surface for calcining. As the workings progress, the hollows are partially filled with slag, and the soil is replaced, so that the land becomes fit for agricultural purposes or planting, and is not disfigured by the hideous mounds of clay and refuse, such as are to be seen in many of the older iron districts.

The iron production in Lincolnshire is only as yet in its infancy, about 30,000 tons being the quantity smelted during the past year; but there can be no doubt but that the trade is destined largely to increase. In the first place, the metal produced is of a quality superior to that of the Cleveland district, which is owing probably to the presence of oxide of manganese largely in the rocks, and its more calcareous nature. Some beautiful specimens of specular pig-iron have been produced at the Frodingham furnaces. The district is also favourably placed with reference to its geographical position: its distance from the Yorkshire coal-field is small, so that while it is within easy reach of fuel, it can send large quantities of the ore into the Yorkshire coal-field for mixing with the argillaceous iron-stone, and this is now practised to a large extent. For shipment it is being placed, by the construction of new lines, in communication with the ports of Goole and Grimsby, while it is also favourably situated for sending supplies into Staffordshire and other inland markets. The metal possesses the qualities of extreme fluidity when melted, and is tenacious in a manufactured state; so that it answers well for hoops and boiler-plates. For general purposes, however, it is improved by the mixture of either Cleveland or hæmatite pig-iron.

The Middle Lias of Northamptonshire has not as yet (as far, at least, as I am aware) yielded iron-stone. The formation is doubtless there, lying about 120 feet under the Northamptonshire iron-stone, which, as already stated, occurs at the base of the Great Oolite. The richness and abundance of this latter ore have probably diverted attention from the former, for it ought not to be forgotten that these Jurassic ores do not force themselves on men's attention, but have rather to be sought for. As I have already described the oolitic iron-stone of this county, I shall therefore pass on to the consideration of the Oxfordshire iron-stone, at the southern extremity of our district.

The iron-field extends over a hilly tract of ground, extending from Edge Hill, near Banbury, on the north, to the valley of the Evenlode, near Charlbury, on the south, near which place it has as yet alone been worked.* The ore belongs to the Middle Lias, and is similar in appearance to the Lincolnshire, and sometimes to the Cleveland stone. It consists of olive-green oolitic rock, more or less calcareous, and weathering rusty-brown. At Fawler the thickness is twelve or fifteen feet, and this may be taken as the average over that part of the field where the iron-stone is richest. Towards the western escarpment of the hills, overlooking the vale of Moreton, the rock decreases both in thickness and quality as an iron-stone; as it does also to the eastward, along the valley of the Cherwell, as far south at least as Aynho. Around Bloxham, Deddington, Great Tew, Hook Norton, and Swalcliffe, it appears to be of good quality, and generally forms nearly level terraces, intersected by narrow valleys—a position peculiarly adapted for economical working and drainage. New lines of railway are now being constructed across the richest portion of the district, placing it within reach of South Wales and South Staffordshire; and,

* At Fawler quarries, the yield of which, in 1864, was 6,666 tons. The iron-stone has also been worked at Steeple Aston.

judging from the experience of Northamptonshire and the adjoining county, it seems probable that a few years hence furnaces will be erected in this district. The quality of the pig-iron produced, as tested by the trials from the Fawler quarries, has been pronounced good, though the yield is variable, as the rock is often superabundantly calcareous, and the average yield of metallic iron will probably not be found to exceed thirty per cent.; on the other hand, it will require little or no admixture of limestone for fluxing.

The rapid increase of iron-smelting in the new districts may be judged by the following statement:—We learn from the 'Mineral Statistics of Great Britain,' compiled by Mr. R. Hunt, F.R.S., that in 1864 the total quantity of pig-iron smelted in the United Kingdom was 4,767,951 tons, from 10,064,890 tons of ore. Of this, the North Riding, Lincolnshire, and Northamptonshire produced 431,929 tons. What the total produce for 1865 may be we are not yet informed, as the statistics for this year have not yet been published; but we shall probably not be far wrong if we estimate it at 6,000,000 tons of pig-iron, of which the Cleveland district, Lincolnshire, and Northamptonshire will have yielded 1,100,000 tons. The proportions therefore of the yield from the New Fields to that of the United Kingdom will have been, in 1864, nearly one-tenth, while in the following year it will have been more than one-sixth of the whole. Considering the rapidity with which new furnaces are being erected in these districts, I shall not be surprised if it should turn out that in the present year the proportion will be one-fourth of the produce of the entire kingdom, and this is exclusive of the large quantities of iron smelted from ores sent into other iron districts.

We have now completed our survey of the New Iron-fields of England through a tract of country ranging from north to south for a distance of 200 miles. The survey might be still further extended if we included the Wiltshire ores, which are of limited extent, and belong to a still higher geological horizon. Enough has probably been stated to show the enormous extent of our resources in this mineral, which is sufficiently abundant to use up the whole of our available coal for its conversion into metallic iron. As regards the quality of the iron produced, it is confessedly inferior to that derived from the clay iron-stones and black bands of the coal measures, still more to that from the hæmatites of Ulverstone and Furness; but for ordinary purposes and for mixing with the finer classes, it is of great value. It is, moreover, supplying the enormous demand of the present generation; and, looking to the future, there can be no question that the Middlesborough district is destined to have no rival in any part of the world.

E M Williams ... lith

M. & N. Hanhart ...

IMPLEMENTS AND SCULPTURES OF THE FLINTFOLK

III. ON THE HABITS AND CONDITION OF THE TWO EARLIEST KNOWN RACES OF MEN.

By W. Boyd Dawkins, M.A. Oxon, F.G.S.

In this age of steam-engines, and electric-telegraphs, and printing-presses, surrounded by all the appliances of modern civilization, with the hum and stir of commerce in our ears, and with our eyes accustomed to the rich cultivated fields, or the densely-populated towns, we find it very hard to realize to ourselves the England or the Europe of 500 years ago, when all these things were not, and when the habits of life which these things have naturally developed, were altogether different. So difficult is it, that with all the old chronicles at hand to furnish a true picture of the life and modes of thought of those times, Lord Macaulay is the only English historian who has attempted to give them even in outline. Still further back the materials for the social history of Western Europe grow more and more scant, and anterior to the time when the Romans conquered Gaul and obtained a foothold in Germany, there are none whatever. Of the social condition of the people who dwelt in Britain, from Cæsar's landing down to the invasion of the Saxons, we know historically next to nothing; the accounts left by Tacitus and other writers recording merely the movements of the Legions, and the establishment and maintenance of the Roman Imperium, with but incidental notice of the habits and customs of the vanquished. But where History is silent, Archæology steps in and wrests from the "speechless past" evidence of the existence, and an outline of the habits of races of mankind that have disappeared. The caves and rock-shelters of Dordogne afford the first traces of the dawn of sculpture and engraving in Western Europe; the tumuli of Scandinavia, Germany, France, and Britain rival the tombs of Etruria in the knowledge they yield of their makers; the Pile-dwellings of Switzerland tell their own story, as well as the buried cities of Herculaneum and Pompeii. In a review of history we realize that nations, like individuals, die, and that from time to time great migrations have destroyed the very existence of certain European peoples. In the Pre-historic times we also see that tribe drove out tribe, and race succeeded race, each bringing with it peculiar customs and habits. In both there is a gradual progress traceable in the arts and sciences, and in all that now makes life worth the living. In carrying man back into the most remote past to a point where Archæology dies away—so to speak—into Geology, we shall be compelled to acknowledge the truth of the saying of the great Pascal, that "the entire succession of men through the whole course of ages must be regarded as one man always living and incessantly learning." The very first man who lifted himself above the beasts of the field by the discovery that a sharp stone or a snare would subserve the purpose of obtaining food better than his unarmed, unaided limbs, laid the foundation of our arts and sciences. From it our culture and knowledge sprang, a giant tree now, but whose development in the glorious future will bear to its present growth the same relation which that growth does now to the parent germ. As the habits of man are essentially dependent upon external physical circumstances, we shall have occasion incidentally to touch also upon them.

The labours of the Scandinavian antiquaries, and especially of Professor Worsaae,* have proved that Pre-historic remains in their country fall naturally into three distinct classes, indicating, if not distinct race, yet certainly different habits and modes of life—first, those of the Stone age, in which the use of metals was unknown; secondly, the Bronze age; and thirdly, the Iron age, in which man acquired a mastery over those metals, and employed them for his various needs. This classification has been found to hold good throughout Europe. The first of these divisions again, that of the Stone, has been subdivided by the French and English archæologists, and for the earlier portion Sir John Lubbock has proposed the term Palæolithic;† for the later the Neolithic age. The introduction of iron did not exclude the use of bronze, nor did the latter drive out the use of the ruder stone. Thus I obtained from a Romano-British burial-ground at Hardham, in Sussex, flint flakes, and a bronze fibula, while some of the oaken coffins were strengthened by iron nails. It is the shape and fashion of the implements and weapons, and not the material only, that are a safe guide to the relative Pre-historic age. We purpose to take the earliest of these—the Palæolithic, and to sketch the habits and condition of the two races of men who lived at that time, the Flint Folk and the Reindeer Folk, and then to trace as briefly as may be the progress of man down to the borders of history.

The gravel-beds of France and England, and the bone caverns of these two countries, and of Belgium, have afforded the earliest known traces of man upon the earth. The original discoveries of M. Boucher de Perthes, at Amiens and Abbeville, followed up by the cautious energy of Mr. Prestwich, F.R.S., prove that man co-existed with the fossil Mammoth and woolly Rhinoceros on the banks of the Somme at a time when it flowed at a much higher level than at present, and when the relations of hill and valley were altogether different in that district. The labours of the latter, and of Mr. Evans, F.R.S., have resulted in the proof that the same race of men lived in Britain from Suffolk on the east as far south as the coast of Hampshire. My own discoveries in Wookey Hole Hyæna-

* 'Primeval Antiquities.' Worsaae. Translated by W. J. Thomas. London, 1849.

† 'Pre-historic Times.' London, 1865 παλαῖος = old, λίθος = stone, νέος = young, λίθος = stone.

den extend their range into Somerset; those of Mr. MacEnery in Brixham into Devonshire; and lastly, those of Dr. Falconer in Pembrokeshire into South Wales. Throughout the whole of this area the same types of flint implements and weapons prevail. A splinter of flint afforded the only cutting edge they possessed; a mass of flint rudely chipped into a point was their only boring tool; large thick rudely-fashioned "spear-heads" their principal weapon. The so-called "sling-stones," either intended for use as missiles, or imbedded in gum, or bound round with withes, as axes, and some pointed masses of flint which may have been used for digging, comprise the list of their remains from the gravel-beds. In the Hyæna-den, at Wookey Hole, I had the good fortune to find, besides the ordinary forms, a small oval, leaf-shaped lance-head [see Figs. 1, 2, 3, 4, p. 336], an arrow-head of chert [Plate, Figs. 1, 2], a bone arrow-head, and a small-pointed bone which may have been a needle. The calcined bones on the floor prove that the use of fire was not unknown, and that the cave was inhabited. The evidence afforded by this scant list of the implements and weapons proves that the race of men who used them were savages of the very lowest order, unacquainted with the art of spinning or of making pottery, and living on the fruits of the chase without the aid of the dog. Those who dwelt in the plains of Somerset were acquainted with the use of the sling and the bow, and tipped their arrows with chert and bone. The ashes found at the mouth of the cave at Aurignac and at Wookey Hole prove that fire was known in that early epoch.

If the condition of man then differed from that of man now in Western Europe, still more did the physical aspect of Europe differ from its present aspect, in its temperature, its animals, and its area. In those early days England formed part of the mainland that stretched out far into the Atlantic. Glaciers descended from the mountains of Wales, the Lake-district, and Scotland, and the winter cold was sufficiently intense to form ice on the rivers thick and strong enough to transport great stones, which now we find in numerous places dropped among the fine gravels in their ancient beds.* In the spring, when the winter accumulation of ice and snow melted away, the lower grounds were covered by extensive floods similar to those which now take place in Canada, the Hudson's Bay Territory, and Siberia. The large areas of silt which they have left behind, prove their former extent; as, for example, that stretching from Brighton at least as far as Portsmouth. The land was covered with dense forests of oak, beech, alder, and Scotch fir, through which the rivers cleft their way to the sea, bearing the carcases of Reindeer or Red-deer, huge Mammoth or woolly Rhinoceroses, or now and then the Musk sheep, and either dropping their bones in various places in their course, or leaving them col-

* See "British Pleistocene Mammalia," by W. Boyd Dawkins and W. Ayshford Sanford. Introduction, Sec. xi., 'Palæont. Soc.,' 1866.

FIGS. 1–4.—FOUR VIEWS OF A FLINT IMPLEMENT FOUND IN THE HYÆNA-DEN AT WOOKEY HOLE, NEAR WELLS.*

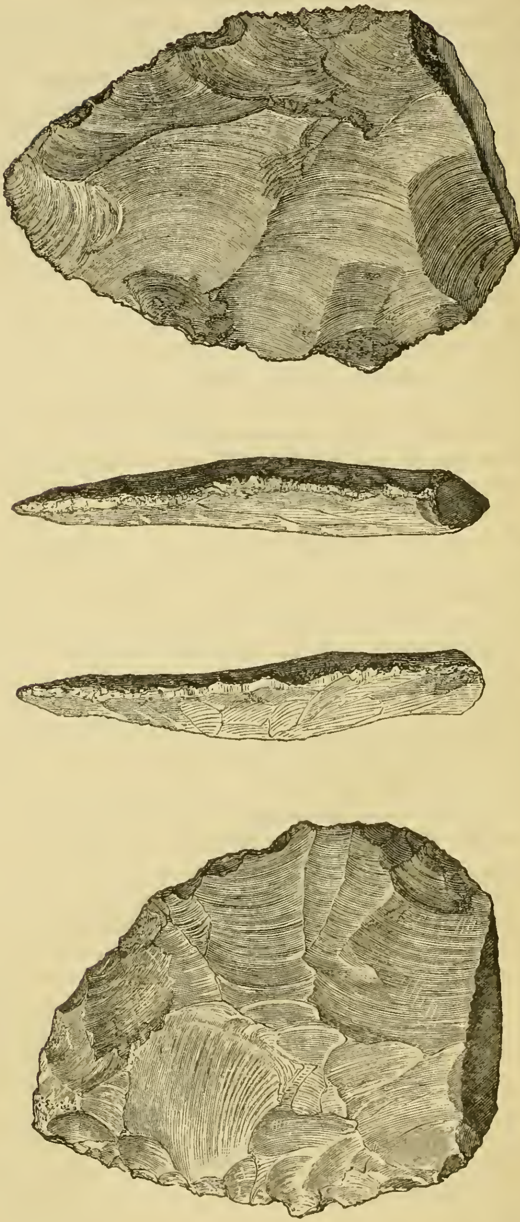


Fig. 1. Fig. 3. Fig. 4. Fig. 2.

* Reprinted from the original blocks of vol. xviii. of the 'Quarterly Journal of the Geological Society,' by permission of the Council of the Society.

lected together by the current, as at Ilford in Essex. The Hippopotamus disputed with the Beaver and the Otter the sovereignty of the rivers. In the forests dwelt two species of extinct Rhinoceros, the Bison and the Urus, the Irish Elk and the Horse, and afforded food for the Wolves, the gigantic Cave-Lion and Cave-Bear, the Cave-Hyena and the Glutton.

On such a scene as this man appears for the first time armed with the rudest weapons of flint, chert, and bone. Exposed like the beasts to the vicissitudes of a climate far more severe than that now obtaining in the same area, living like the Hyænas in caves wherever he could find them, sheltered from the cold where there were no caves by a rude hut, probably little better than the lair of a wild beast, preying on the wild animals around him, he fought for dear life itself with the great carnivora. Separated from the beasts by the possession of reason, he had already mastered the use of fire, and armed with the bow, the spear, and the sling, made good his foothold in the Fauna of Western Europe.

The contents of the cave of Aurignac, examined by M. Lartet in 1860, inclined him to the belief that the ancient folk who used the implements found both within and outside the cave were contemporary with the Mammoth and woolly Rhinoceros, that the human skeletons found were interred at a time when the extinct Pleistocene mammalia lived in France, and that some of the animals, and especially a young Rhinoceros, had been eaten at the funeral feast.* If, indeed—to quote the classic words of Sir Charles Lyell —"the fossil memorials have been correctly interpreted—if we have here before us at the northern base of the Pyrenees a sepulchral vault with skeletons of human beings consigned by friends and relatives to their last resting-place—if we have also at the portal of the tomb the relics of funeral feasts, and within it indications of viands destined for the use of the departed on their way to a land of spirits; while among the funeral gifts are weapons wherewith in other fields to chase the gigantic deer, the cave-lion, the cave-bear, and the woolly rhinoceros—we have at last succeeded in tracing back the sacred rites of burial, and more interesting still, a belief in a future state, to times long anterior to history and tradition."† When, however, it is considered that the cave was discovered eight years before it was scientifically examined, and that the human skeletons found therein by the discoverer, a workman named Bonnemaison, were removed and buried in the cemetery of Aurignac, where they cannot now be found, the contents of the cave being thus disturbed, the inference that the skeletons are of the same age as the extinct mammals, and of the flint and bone implements, seems to be faulty. The *gisement* of the skeletons rests upon the hearsay evidence of what occurred eight years previously; no person interested in the

* 'Ann. des Mines, Zoologie,' t. xv., p. 177.
† 'Antiquity of Man,' pp. 192–3. First edit., 1863.

problems concerning the human race that have arisen since 1852 having so much as seen them. Had indeed the Palæolithic savage been in the habit of burying his dead in caves, we should not be seeking in vain for perfect human crania unequivocally of that early date up to the present time; some trace of such interment would surely have been found in the numerous caves explored in France, Germany, and Britain. While therefore it is clear that Aurignac was used for a place of sepulture at some time or other, the inference drawn by the eminent French Zoologist, M. Lartet, and endorsed by the great authority of Sir Charles Lyell,* that it was so used at a time when the great extinct mammalia dwelt in France, does not legitimately flow from the facts adduced. We are therefore still in ignorance of the mode in which the savages of those days disposed of their dead and as to their belief in a future state.

Thus scant is our knowledge of the earliest known men, the Flint Folk *par excellence*, a race that is as truly fossil and extinct as the Mammoth and woolly Rhinoceros with whom they lived.† To M. Lartet and the late Mr. Christy we owe the proof of the existence of a second race of men in the South of France, in the Department of Dordogne, in the valleys through which flow the Vezère, the Dordogne, and their tributaries. They dwelt in caves and under sheltering rocks, and accumulated around their dwellings the remains of the animals they ate, and vast quantities of the implements and weapons they used. In all the caves and rock-shelters except one, the remains of the Reindeer were most abundant, and evidently constituted the chief food of these savages of the Dordogne, who may therefore be conveniently termed Reindeer Folk, in contradistinction to the Flint Folk described above. The presence of the Mammoth and Cave-lion (the remains of which were few) in the refuse-heaps, proves that the age of the Reindeer Folk was that of the great extinct Pachydermata, while the occurrence of the Musk-sheep and Reindeer, animals confined to the cold regions of the North, indicates the arctic nature of the climate at that time in France. The implements are of a higher order and denote a higher degree of civilization than those of the Flint Folk.

The lance-heads, however, from the cave of Moustier are of a different fashion to the rest, and approximate, as M. Lartet observes, to those found at Amiens and Abbeville, and possibly belong to the same age as these latter. This is rendered more probable by the exact agreement of some of those from Moustier with the figure of one from Wookey Hole delineated above (Figs. 1–4. p. 336).‡

A list of the implements and weapons comprises lance-heads, arrow-heads, scrapers, flakes, and awls of flint; hollowed stones

* 'Antiquity of Man,' p. 181. First edit., 1863.

† 'Revue Archéologique,' 1864.

‡ In 1864 I had the good fortune to find an implement agreeing exactly with the two mentioned above, on the surface of a gravel-bed near Faversham. It is now in the collection of Mr. John Evans, F.R.S.

which may have been used for mortars or for obtaining fire by friction; sundry ornaments made of bone, antler, and teeth; a whistle made out of the first phalanx of a large stag; arrow-heads, spoons, and needles made out of bone or antlers. One of the arrow-heads cut out of the antler of a reindeer is remarkable for the alternate barbs and for the grooves on their surface, which may have been intended to contain poison. An implement from the same cave [Plate, Fig. 3], made of the same material, with the barbs on one side, was probably a fishing or fowling spear. The most remarkable remains, however, by far, are the figures of animals engraved upon stone, antler, bone, or ivory, the earliest traces of sculpture known in Western Europe. A slab of schist from Les Eyzies bears the outline of a deer; the lines, however, are too confused for specific identification. The rock-shelter of Laugerie-basse has furnished an outline of the hinder quarters of a large ox, boldly and skilfully engraved on the palmated antler of a reindeer. On a second fragment of reindeer antler the ancient artist has depicted the figure of a horned ruminant, probably the Bouquetin, of which the remains were abundant, and as he had no room to draw the hindlegs in their natural position, he doubled them forwards until the hoofs touched the animal's belly, and thus completed the whole beast. [Plate, Fig. 7.] Other fragments of antler from the same locality were fashioned into ornamented spoons or marrow-scoops; and in one case, a reindeer kneeling on his fore-legs, with eyes, ears, antlers, and tail most distinctly cut, formed the handle of an implement of some kind.

From the rock-shelter of La Madelaine has been obtained most remarkable and unlooked-for evidence of the co-existence of man with the mammoth in a fragment of fossil ivory [Plate, Fig. 8], bearing upon it the well-defined figure of the extinct species of Elephant to which it belonged.* The artist has given to it not only the tusks with eccentric curvature, which are so common in the drift gravels, but also has marked in a most unmistakable way the long hairy mane which we know, from the discovery of the frozen mammoth carcases in the North of Russia, characterized that extinct animal. This specimen, therefore, is most important, not only as an example of the early dawn of art, but also because it stamps the age of the artist to have been that of the Mammoth.

Human teeth and bones were also found in both the caves and rock-shelters, which were in precisely the same state of preservation as the bones of the animals which had been used for food, and probably owe their presence to the same want of care for the dead among the Reindeer Folk as is now exhibited by the Esquimaux. M. Lartet, however, hesitates to relegate the human remains to the age of the Reindeer: "D'abord parce qu'il est peu vraisemblable que les aborigènes de cet âge, que nous avons pu voir dans une station

* 'Ann. des Sciences Naturelles.' 5e ser., t. iv., 6 cahier.

plus ancienne, à Aurignac, professer une sorte de culte pour les morts, aient enseveli un des leurs dans le lieu même ou ils mangeaient; ensuite, parce que l'on n'a aperçu auprès de ces débris humains aucuns des accessoires habituels et à signification symbolique que l'on retrouve jusque dans les sépultures les plus anciennes des temps primordiaux."* These two reasons seem to me to be invalidated by the equivocal evidence afforded by the cave of Aurignac. As, however, the human remains in the cave of Eyzies and the rock-shelter of La Madelaine were found *in situ* by experienced observers, the evidence for their contemporaneity with the Reindeer seems to be as good as that afforded by the bone of any other animal found.

These remains give us a most vivid picture of the habits and mode of life of the time. The great Carnivora had not yet disappeared from Western Europe, and of the great extinct Pachyderms the Mammoth was sufficiently familiar to the eye of the artist to be faithfully engraved. Herds of Reindeer, along with the Horse and the Red-deer, wandered through Central and Southern France. The great Arctic Musk-sheep and the Antelope Säiga of the Siberian steppes were occasionally killed by the Reindeer Folk. We can almost see the hunter returning to his cave, or rock-shelter, bearing upon his shoulders the Reindeer that he had slain, or portions of a Bison, or Urus, or Horse (for they were cut up where they fell), or with fish from the Vezère or Dordogne, or with birds that he had snared or speared, to be hastily cooked and greedily devoured by his family and friends. We can see him clad in skins perpetuating the remembrance of the chase by engraving on antlers, or bones, or stones the figure of a fish, a Red-deer, Horse, Bouquetin, and even of a Mammoth, or preparing skins for clothing with the rude flint scrapers, or sewing them together with the bone needles. And we can see him chipping his rude spear-heads, knives, and scrapers, and all his edged tools, out of a block of flint, and the chips he struck off, and the flint core he threw away, are still where they fell, on the heap of split bones, ashes, and broken implements upon which he dwelt. He was unacquainted with the art of making pottery or of spinning; he never ground his implements or weapons, and was unaided by the dog in hunting. Yet, even in this poor savage we find an idea that in the time which has elapsed between his sojourn in France and our own day has borne the most glorious fruits. The idea of representing familiar objects has developed, on the one hand, into the marvellous works of a Phidias and a Raphael; on the other, into the invention of hieroglyphics, of the alphabet, and of printing.

This early people seem to have been a different race to the Flint Folk, because, although both lived very much under the same physical conditions, in no case are their implements or weapons

* See 'Revue Archéologique,' 1864.

found together. Possibly the Reindeer Folk may have dwelt in one area at the same time that the Flint Folk inhabited another; but there is no evidence of their living in the same district at the same time. The more varied forms and the higher finish of the weapons and implements of the Reindeer Folk, as compared with those of the Flint Folk, make it highly probable that the former were not only the more civilized, but also the more modern of the two Palæolithic races.

The question who were the Reindeer Folk may be answered with some approximation to the truth by a comparison of their implements and their habits with those of savage tribes living under the same or similar circumstances. A comparison of the scraper of the Reindeer Folk [Pl. 1, Fig. 9] of M. Lartet's essay in the 'Revue Archéologique' with that of the Esquimaux figured by Sir John Lubbock ['Pre-historic Times,' Figs. 76–78] shows that there is but little difference between the two. The barbed bone ['Quarterly Journal of Science,' Plate, Fig. 3] and the bone needle [Fig. 5] agree remarkably with those in use by the Esquimaux of Igloolik at the time Captains Parry and Lyon visited Melville Peninsula in 1821 [Figs. 4 and 6]. The marrow-spoons of both these peoples are remarkably alike, and the habit of carving various animals is common to both, and of splitting the bones for the sake of the marrow. The method also of the accumulation of the bones of the animals, and the occurrence of human remains in the refuse-heaps of the Reindeer Folk, is explained by the state of an Esquimaux camp in the Island of Igloolik. "In every direction around the huts were lying innumerable bones of walrusses and seals, together with skulls of dogs, bears, and foxes, on many of which a part of the putrid flesh still remaining sent forth the most offensive effluvia. We were not a little surprised to find also a number of human skulls lying about among the rest within a few yards of the huts, and were somewhat inclined to be out of humour with our new friends, who not only treated the matter with the utmost indifference, but on observing that we were inclined to add some of them to our collections, went eagerly about to look for them, and tumbled, perhaps, the craniums of some of their own relations into our bag without delicacy or remorse."* A carelessness of the dead similar to this would account satisfactorily for the human remains of the Reindeer Folk being found along with relics of the feast at La Madelaine and Les Eyzies. The small handles, again, of the implements found in Dordogne would prove that the Reindeer Folk were a small race. They were ignorant of pottery, and slaughtered the Reindeer and Musk-sheep for food. In fine, the cumulative evidence as to their race points towards the Esquimaux, who live under somewhat similar conditions in a very similar manner. There is nothing inherently improbable in this

* 'Parry's Second Voyage,' p. 280. 4to.

view that would extend the former range of the Esquimaux as far South as the Alps and Pyrenees, nor in the fact of their retreat so far North along with the Arctic Fauna. The hostility of invading tribes armed with better weapons would account for the latter, without any climatal reason being called in. In North America the dread of the Red Indian keeps a broad belt of country utterly uninhabited by them at the present day.†

Whether or not the Reindeer Folk kept herds of tame Reindeer, like the Lapps and Finns of Northern Scandinavia, is altogether an open question. The eminent French Palæontologist inclines to the belief that they did not, and his belief is shared by Mr. Christy, with whom he explored the refuse-heaps.

The following list of the implements and weapons of the two races of the Palæolithic age shows at a glance the immeasurable superiority of the Reindeer Folk over the Flint Folk:—

Palæolithic Implements and Weapons.	Flint Folk of France, England, and Belgium.	Reindeer Folk of Dordogne.
Rude massive Spear-heads of Flint	*	—
Small Lance-heads	*	*
Sling-stones of Flint and Chert	*	*
Leaf-shaped Flint Spear-heads	*	—
Flint and Chert Arrow-heads, without barbs	*	*
Flint Flakes	*	*
Flint Awls	*	*
Flint Scrapers	?	*
Bone Arrow-heads, without barbs	*	*
Bone Arrow-heads, with barbs	—	*
Barbed Spear-heads of Antler	—	*
Bone Needles	?	*
Bone Ornaments	—	*
Bone Spoons or Scoops	—	*
Stone Mortars (?)	—	*
Outlines of Animals on Stone, Antler, Bone, and Ivory	—	*
Figures of Animals cut out of Antler	—	*

They had discarded the use of the rude massive "spear-heads" and the small leaf-shaped lance-heads of the latter; had added barbs to their hunting-arrows and spears, and had learned that bone, antler, or ivory were materials better adapted for the supplying of many of their needs than the harder and less tractable flint. The valuable work now being published in parts by M. Lartet and the representatives of the late Mr. Christy, will most largely supplement the list of the implements of the Reindeer Folk given above, and will increase our estimate of their civilization. The marvellous remains from Dordogne, in the collection of the latter, read by the light of the museum that he had spent years in forming, of implements and weapons of savages from all parts of the world, and

† See 'Franklin's Journey to the Polar Sea, 1819–22, 1825–27.'

aided by the osteological learning of M. Lartet, cannot fail to cause as complete a restoration of the habits and customs of the Reindeer Folk as that of the great secondary reptiles by Professor Owen and Dr. Mantell.

An examination of the remains of the wild animals associated with those of Palæolithic man leads to some curious results. From the following table all those animals which have not been proved to have co-existed with the Flint Folk and Reindeer Folk, though they may have been living at the time, are rigidly excluded:—

Palæolithic Mammals.	Bone Caves and River deposits in France, Germany, and England, associated with remains of the Flint Folk.	Caves and Rock Shelters of Dordogne.
The great Sabre-toothed Lion or Tiger	*	—
The Cave Lion	*	*
The Wild Cat	*	—
The Cave Hyæna	*	*
The Ermine	*	—
The Wolf	*	*
The Fox	*	*
The Badger	*	—
The Cave Bear	*	*
The Brown Bear	*	—
The Urus	*	?
The Bison	*	*
The Musk-sheep	—	*
The Common Elk	—	?
The Red Deer	*	*
The Reindeer	*	*
The Roe Deer	*	*
The Irish Elk	*	*
Antelope Säiga	—	*
Elephas Antiquus	*	—
The Mammoth	*	*
The Wild Boar	*	*
The Hippopotamus	*	—
The Woolly Rhinoceros	*	—
The Leptorhine Rhinoceros of Professor Owen	*	—
The Horse	*	*
The Ibex	—	*
The Chamois	—	*
The Tailless Hare	*	—
The Common Hare	*	*
The Common Rabbit	*	—
The Water Rat	*	—
The Meadow Vole	*	—
The Field Vole	*	—
The Pouched Marmot	*	*
The Greater Horse-shoe Bat	*	—

* A list of known animals in the Stone, Bronze, and Iron age will be found in the Rev. C. W. Kett's paper on "Pre-historic Records."—'Quarterly Journal of Science,' April, 1865.—Editors.

The extinct mammalia split up into two groups of unequal antiquity. On the one hand, we have the Sabre-toothed Lion (or Tiger), the Elephas Antiquus, the Hippopotamus, and the Woolly and Leptorhine Rhinoceros, found along with the remains of Flint Folk; and with the exception of the two last, began to live in the remote epoch called the Pliocene. On the other, the only two extinct species found in the refuse-heaps of the Reindeer Folk are the Irish Elk and the Mammoth, both of which sprang into being in the Pleistocene Period, and the former lingered on after the disappearance of the latter, and is repeatedly found in the silt of river-beds, and the lacustrine marls underlying the peat, which are of a comparatively modern date. The legitimate inference to be drawn from this is, that those deposits, containing not only the larger proportion of extinct mammals, but also an older group, are of higher antiquity than those containing a smaller proportion and a newer group; or, in other words, that the Flint Folk preceded the Reindeer Folk in time. Thus the evidence afforded by Palæontology corroborates the inference drawn from a comparison of the implements and weapons with reference to the relative age of the two Palæolithic Races.

To this view, indeed, it may be objected that the remains found in a den of Hyænas, or in an old fluviatile or lacustrine deposit, afford a better idea of the Fauna of any given district than those selected from among the wild beasts by man for food, and therefore that the absence of any particular animal from the refuse-heaps is to be accounted for by the fact of its not being met with by man, and does not prove the non-existence of the animal at the time. Had, however, any of the old Pliocene mammals co-existed with the Reindeer Folk, there is no reason why they should not have fallen victims as well as the other large mammals, the Mammoth or the great Urus. While, therefore, it is just possible that one or even the whole of the older animals *may* at a future time be discovered in association with the remains of the Reindeer Folk, the probability is that they will not be so found.

The three animals that specially characterize the Reindeer deposits of Dordogne as compared with those of the Flint Folk age, are the Antelope Säiga, the Ibex, and the Chamois; of these the former ranges now through the great central plateau of Asia, the second lives in the Pyrenees, and the last in the Alps.

Thus meagre is the outline which the scant materials allow to be drawn of the habits and condition of our earliest ancestors who lived in the Palæolithic age, — an age that coincides in part with the Pleistocene or Quaternary Period of the geologists. They passed away like many of the other mammalia, and were supplanted in Western Europe by Folk of a different race, whom Sir John Lubbock terms Neolithic. Without losing any of the useful arts of the preceding age, these invented the use of pottery, and were not ignorant of the art of spinning. They dwelt in huts, the bottoms of which are now known under the name of hut-circles, sunk in the earth, or raised on piles driven into the shallows of lakes, as in Switzerland. The tumuli spreading over France, Germany, Britain, and Scandinavia prove their belief in a future state, as well as their reverence for the dead, whom they buried without burning. They improved upon the rude unground Palæolithic implements and weapons, by adopting the custom of grinding and polishing them, and of making them out of many kinds of stone not used before, as well as by the adoption of new forms. Universally they had pressed the dog into their service, and in the Pile-works of Switzerland present us with the earliest known assemblage of *domestic* animals, the horse, pig, goat, sheep, and ox. The first of these was as rare as the last; the small short-horned variety of the existing species was abundant. They were essentially pastoral, but lived upon the fruits of the chase, the Urus and the Red-deer, as well as upon their flocks and herds. The cakes and cereals found prove that they were acquainted also with agriculture.

Sir John Lubbock infers that the tribes who have left their refuse-heaps on the Scandinavian coasts belong to an early period of the Neolithic age. Among other remains of their feasts are bones of the Great Auk (Alca impennis), which has become extinct in Europe during the present century. The oysters which composed their principal food are no longer to be found in the neighbouring seas,—a fact that would imply a physical change in the Baltic since their time, which has caused the salt water to become diluted with fresh to a greater extent now than formerly. Their habits were probably very similar to those of the savages of Tierra del Fuego at the present day.

Just as the Neolithic superseded the Palæolithic races, so was the former supplanted by the bronze-using Folk, who arrived in Europe before the dawn of history, and lived there up to the time when history begins. Their peculiar bronze swords without a guard are found throughout Western Europe, and are sometimes most tastefully ornamented. Out of this material also beautiful ornaments were made, and many of the implements and weapons which were used by the Neolithic savage. Since "Cornwall and Saxony are the only known European sources of tin," Sir John Lubbock sagaciously observes, "the mere presence of bronze is in itself a sufficient evidence not only of metallurgical skill, but also of commerce." They were acquainted with the use of the potter's-wheel, and were in the habit of *burning* their dead. For many purposes they still used stone, and doubtless the poorer made use of it for their axes, long after it had been discarded by the richer classes. The discoveries in the Swiss Lakes prove that the Bronze Folk possessed abundance of horses, and relied for their subsistence more upon their flocks and herds than upon the chase. They were more pastoral than the previous Neolithic inhabitants of the district.

The date of the introduction of iron into Western Europe cannot be satisfactorily determined. Its use had, however, spread through France, Britain, and Germany before the inhabitants of those countries came into collision with the Roman legions. The iron-using people of Gaul were sufficiently civilized and provided with weapons to be a formidable enemy to Rome in the height of her power, to oppose her disciplined troops in the field with chariots and cavalry, and on the sea to fight for a whole day with the Roman fleet off the coast of Armorica. In Britain and in Switzerland they also used chariots. The pages of Cæsar and Tacitus will give an adequate account of their civilization and habits.

In a review such as this of our Pre-historic ancestors, we must bear in mind that the absolute age of any one of the races is altogether a matter for conjecture. We can simply say that stone preceded bronze, and the latter iron, while we are ignorant of the length of time during which each of these materials was in use, as we are also of the method of its introduction, whether sudden or gradual. In this point, indeed, History differs from Archæology, that it gives the *absolute*, while the latter gives the *relative* date.

In these pages we have traced man from his earliest appearance on the earth down to the borders of history, and we have seen how, as he grew older, he profited by his experience, and slowly widened the chasm between himself and the brutes, by making his life more and more artificial. From the past it is impossible not to turn to the future and ask ourselves, whether there be any limit to the progress of the human race? Has man yet attained his full manhood? In the ages that are coming, will he not continue to win fresh victories over nature and her forces, each of which victories will form the basis for another? and as the fetters which bind him to the brutes are broken one by one, will he not grow more and more godlike, until the brutal portion of his nature be altogether swallowed up by the spiritual? Such an augury as this is warranted by a consideration of the past, by the study of History and of Archæology, and of the course of nature written in the great stone-book on which we live.

EXPLANATION OF PLATE.

Figs. 1 & 2. Arrow-head of chert, from Wookey Hole.
Fig. 3. Fishing-spear (?) of reindeer-horn, from the cave of Moustier.
" 4. Barbed bone in use at present by the Esquimaux of Igloolik, for comparison with Fig. 3.
" 5. Bone needle in use by the Reindeer Folk.
" 6. Bone needle in use by the Esquimaux of Igloolik, for comparison with Fig. 5
" 7. Sculptured figure of a horned Ruminant on a fragment of Reindeer antler from Laugerie-basse.
" 8. Sculptured figure of the Mammoth on a fragment of ivory belonging to that animal, from the rock-shelter of La Madelaine.

IV. SCIENCE AND CRIME.

THE "MOUNTAIN ASH" MURDER.

It has frequently happened in the history of crime that some great culprit has been arraigned for poisoning, and medical or chemical evidence has been called by the prosecution as well as the defence. On such occasions it has sometimes occurred that men of the highest scientific attainments, taking opposite sides in the trial, have given evidence on apparently simple scientific questions of a totally contradictory character. Under such circumstances the counsel for the defence has not unnaturally taken the utmost advantage of the difference of opinion, and in a few isolated cases, perhaps, great criminals may have escaped the punishment which their crimes deserved. "The world," always more ready to criticize and condemn new movements, than to inquire carefully into their merits, has, in consequence of these occasional anomalies in scientific evidence, been disposed to look with contempt upon the efforts of science in the detection of crime; and "differing doctors" have become a by-word in matters of criminal law. But instead of acting as an obstruction to the course of justice, scientific investigation has become the terror of evil-doers, and if it has not succeeded in putting an end to certain classes of homicide, it is simply because criminals are either so foolish as to suppose that *their* case has been so cleverly managed as to defy detection, or so wicked as to be deterred by no considerations whatever from the execution of their designs.

We could point to innumerable cases where the administering of poison has been suspected by the medical attendant or relative, and it has been detected in the chemist's laboratory, but we feel sure it is unnecessary to adduce any evidence in proof of this to our readers; to them it must be a fact perfectly familiar in the annals of crime. Link by link the untiring chemist has formed the chain of evidence; here tracing the death-potion in the tissues, there in the stomach, there again in the heart or vascular system; and when one reads the accounts of these trials, how unerringly the guilt is almost in every case brought home to the heartless transgressor, it appears surprising that there should still remain men insensate enough to suppose they can tamper with the human system without certain detection.

Added to this facility for tracing poison, the microscopic study of the blood-corpuscles of the vertebrata has given additional means for exposing murder and violence, and recently a third method, more exquisite than any hitherto known, has been added to the list of silent, invisible detectives.

When our correspondent, Mr. H. C. Sorby, first published in these pages his astounding revelations concerning the detection of blood in fabrics,* when he told us that he could trace the presence of the vital fluid months after it had been spilt, and after the fabric had been repeatedly washed with the view to obliterate the stains, we had the pleasure on the one hand of receiving communications from scientific men who at once appreciated the great value of the discovery, and on the other hand we were amused by the sceptical shoulder-shrugs of "the world," which would be "very sorry to condemn a man to death upon such evidence."

Without here discussing the propriety of condemning a man to death on any evidence or for any crime, we have to point out the fact that "the world" is again, as it has often been and often will be, erroneous in its judgments on scientific matters; for largely if not entirely in consequence of the investigation by spectrum-analysis of the blood-stained wood of a hatchet-handle, a man at Aberdare has been sentenced to death for one of the most deliberate, cowardly, atrocious murders that the world ever witnessed.

The crime in question, known as the "Mountain Ash Murder," was committed last September by a youth, aged eighteen, called Coe, the victim being another young man called John Davies, residing in the same locality, and the trial came off in March of the present year.

It is unnecessary to pain our readers by the full details of this crime, which attracted considerable attention at the time; and we shall state as concisely as possible how scientific research succeeded in securing the conviction of the murderer. On a certain Saturday in September, the day on which he received his wages, the murdered man was last seen in company with the criminal who has since perished on the scaffold; and from that time until the 1st of January nothing was heard of him. On that day a farmer, also called John Davies (the same name as the deceased), discovered a dead body in a wood in the neighbourhood of "Mountain Ash," the head being severed from the body, and lying at some distance from the trunk. He at once applied to the police, by whom the body was removed. It was already, to a great extent, decomposed; but was identified as that of John Davies by his father; and here comes the first result of scientific acumen. The father recognized a portion of the clothing found upon the body; but this would hardly have sufficed in evidence. Young Davies had, however, had a back tooth drawn by Mr. Brown, a surgeon, *two years before the murder;* and that tooth had been preserved by the unfortunate young man's father. It was now inserted into the jaw of the corpse, and "it fitted as well as it could, considering the length of time which had elapsed."

* "On the Application of Spectrum-Analysis to Microscopical Investigations, and especially to the Detection of Blood-stains." By H. C. Sorby, F.R.S. 'Quarterly Journal of Science,' No. 6, April, 1865.

So much for the identification of the body; now for the evidence which saddled the murderer with the crime.

The blows upon the head of the deceased which caused his death had been inflicted, the medical men said, with "some sharp cutting instrument," and it appears that on the day of the disappearance of Davies, Coe had borrowed an axe of a man called Swan, which he afterwards returned secretly and in a dirty state. This axe was carefully examined, and, as it had been cleaned by Coe on his being remonstrated with by Swan for returning it in such a state, it showed no external traces of blood; but the investigators, Dr. William B. Herapath, F.R.S. (of Bristol), and Mr. Brown, the gentleman already referred to, removed the handle and examined that portion of it which had been concealed by the blade. There they found what appeared to be stains of blood. This it was clearly proved to be by spectrum-analysis, and by ordinary microscopic observation. Dr. Herapath said, in his examination, that finding the evidence resulting from the detection of globules to be small, "I obtained more numerous sections of the coloured surface of the handle of the hatchet—immersed them in distilled water and obtained thereby a slightly coloured solution, which after filtering, was ready for chemical tests, and for optical examination by the micro-spectroscope. I subjected this fluid to the action of light, and it had undoubtedly the properties peculiar to a solution of blood. When a solution of blood was examined in this instrument (instrument here produced) the fluid absorbed some of the rays of light, and thus altered the spectrum or rainbow. Within the green and on the border of the yellow rays two dark absorption bands were produced by the blood fluid. Only one other substance* would produce two dark bands—that is cochineal dissolved in ammonia, but the position of the two bands was different. The spectroscope alone would not enable me to *readily* distinguish between the two, but combined with chemical examination it would satisfactorily do so. From this optical test I was satisfied that the sections of the hatchet had been stained with blood—and by chemical analysis I also demonstrated it was blood. The combination of the three tests showed that the substance on the hatchet must have been blood."

The globules, or blood-corpuscles we should rather say, resembled those of the human subject; or, as Mr. Brown, the surgeon, is reported to have said in cross-examination, "The globules of the blood on the hatchet were nearly the same size as those of a pig, which is the nearest in size to that of a human being."

The accused, therefore, had been last seen with the murdered man in the neighbourhood of the scene of the murder; he had borrowed and returned at the time of the disappearance of the

* Dr. Herapath should have said, "is at *present* known to produce."

victim just such an instrument as might have been used to inflict the injuries which caused death, and on that instrument the traces of blood had been discovered by scientific research.

There were many other circumstances of minor importance, which served as links in the chain of evidence, the most condemnatory of which were that Coe had made some remarks about a supposed murder at Mountain Ash, between the time when his victim disappeared and the body was found, which showed that he was aware such a murder had been committed; and that whilst Davies had been robbed by his murderer, Coe had been rather flush of money; and although the prisoner received the benefit of an anxiously-considered summing-up on the part of a most just and merciful judge, the weight of evidence was too overpowering to leave room for doubt on the minds of the jury, and he was convicted of wilful murder after an hour's deliberation. Before being executed he confessed his guilt.

Now, *we* must be permitted to "sum up." The full value of Mr. Sorby's great discovery is not exhibited by the remarkable trial to which we have here cursorily alluded. The time will come when spectrum-analysis, which has already taught us what distant suns and nebulæ are made of, will reveal to the custodians of human life that blood has been spilt upon some rag or fragment of clothing, and that discovery will serve as the *first* link in the chain of evidence that shall bring some wretched malefactor to his doom. Or, who knows but the very fact of such means of detection being in existence, may drive a stricken conscience to confess the crime, which might otherwise have remained unknown here below! Mr. Henry Sorby may, or may not, receive the reward due to him for his untiring researches; he may, at some future time, have a paltry honour pompously offered to him by some person high in office, and he *may* refuse that honour. It will be the best thing he can do, for his name will be bound up in the same volume that chronicles the works of Newton and Harvey, of Jenner, Bunsen and Kirchhoff, of Fraunhofer, and of all men of science who have, directly or indirectly, enlisted the light of the orb of day into the service of humanity; and this is a higher honour than any that princes or governments can bestow.

But let it not be supposed, because we thus sing the praises of scientific men, that we are so wanting in plain matter-of-fact knowledge as to place implicit faith in their evidence. In the first place, chemists and doctors of medicine have feelings; and, secondly, they cannot be pronounced free from prejudice. If our readers could but look over our shoulder as we scan some of the pamphlets which are sent to us from time to time, wherein the most extraordinary crotchets are chronicled, and the most grotesque hobbies ridden, often by men of science and renown, they would never suspect us of placing implicit faith in the judgment of all scientific investigators or of recommending a hasty verdict upon such evidence alone. When careful scientific research is supported by what is known as "circumstantial evidence," that is, where the circumstances under which a crime has been perpetrated are such as to render the scientific revelations credible; or, *vice versa*, where the results of scientific observation confirm the conclusions drawn from circumstantial evidence such as is usually deemed valid in courts of law, there science comes in as a witness to be respected and believed; and it will be found that every day the researches of chemists, physiologists, and microscopists are adding to the store of unquestionable facts which may be employed with increasing safety and confidence in the decision of criminal cases, and more especially in those most inhuman and detestable crimes, poisoning and assassination.

And, finally, let us on these grounds recommend barristers engaged in criminal cases, and members of the press employed in reporting such cases, to devote a little of their leisure time to the study of those branches of science without some acquaintance with which they will ere long find it impossible to pursue their respective avocations; and which will at once relieve their remarks and reports from those imperfections which raise a smile in the countenance of the scientific man, as he hears or reads the reports of cases involving the employment of technical information, or expressions in daily use in the scientific world.

V. BRITISH VOLCANIC ROCKS.—HINTS TO HOME TOURISTS.

By Archibald Geikie, F.R.S.

Summer, with its holidays, has come round upon us again, and now that the uneasy state of the Continent has well-nigh closed many of the channels through which our tide of tourists dispersed itself over Europe, the question, "Where shall we go?" becomes a somewhat momentous one to those who had proposed to themselves something more than a mere round of sight-seeing. Perhaps, if geological tastes were in the ascendant, it had been intended to ramble for a while among the traces of old glaciers on the Italian Alps, to take a few weeks amidst the extinct volcanos of the Rhine, or to peep into the geology of some pleasant upland in Central Germany. But it is hardly within the power of the lover of science to imitate Sydney's muse, who

> "Tempered her words to trampling horses' feet."

He had better in the meanwhile content himself with keeping out of the way both of trampling horses and marching men. And if he can only be persuaded that there are nooks, nay, whole leagues of ground, within his own country which will furnish him with ample recreation, both bodily and mental, he may, in the end, be brought to believe that, after all, it would not do his island countrymen a mortal injury were the Continent closed against them periodically, if they could thereby be driven to look a little more narrowly at their own land. One who has taken the trouble to make himself master of the elements of geological observation carries with him an immensely augmented source of enjoyment. Even on the ordinary tourist "routes," he can note by the way features which serve at once to heighten and to perpetuate the impressions produced by natural scenery. And when he chooses to strike away from the beaten track, and to discover for himself new wonders in scenery and new facts in science, he enjoys a succession of pleasures of which there are, perhaps, few purer or more lasting. To such an one, it may not perchance be unseasonable to suggest a field of research where the reapers have not been so numerous as in some others adjoining, and where, in consequence, there still remain a good many sheaves to be gathered—*viz.* the history of our old British volcanoes. Whether he chooses to settle down at some pleasant centre for excursions, or to make a leisurely tour through some selected parts of the country, he may still be able to carry his task with him. He will find this history legibly graven on many a hill-side in Wales, in Derbyshire, and the north of England. It is told with a strange impressiveness by hundreds of hills and valleys in the centre and south of Scotland, and throughout the chain of the Inner Hebrides; while it may be learned, too, in not a few districts of Ireland, from the cliffs of Antrim to the coasts of Waterford.

According to a vague popular belief, most of our more prominent and rugged hills owe their origin to primeval "volcanic eruptions." Thus a serrated ridge, a cluster of craggy heights, a narrow gorge, a deep half-enclosed corry or *cwm*,—these and other like features are readily seized upon by the imagination as evidence of earthquakes and volcanoes. The fanciful explanations that used to be given of them have faded away, only, however, to be replaced by others in which the fancy is hardly less rampant. The "Devil's Punch-Bowls," and "Giants' Basins" are now dimly thought of even by schoolboys as so many "craters;" and the familiar peaks and clefts in which the superstition of an older time saw the handiwork of witches and warlocks, are now popularly made to tell of vast terrestrial convulsions. So far, therefore, the spread of scientific knowledge has been able to dispel the old notions; but it has not yet advanced far enough to put the true ideas in their stead. In this, as in so many other matters, we seem to be passing through a period of transition between the exploded superstitions of our ancestors and that wide diffusion of science in the popular mind which, we are led to believe, will mark the ages of the future. In the meanwhile, such words as "volcanic," "cataclysms," "upheavals," "convulsions," and a good many more, are commonly used, and sometimes even by scientific people, in a vague, misty sense, to account for phenomena which have arrested the attention, but of which no satisfactory explanation has occurred. And so the change from the devil and the witches has not always been very much for the better; for, in truth, most of the present outlines of the surface of the country may just about as legitimately be ascribed to the agency of evil spirits as to that of volcanoes.

When we set ourselves seriously to study the matter, we soon learn, perhaps to our surprise, how small is the proportion which the number of really *volcanic* hills bears to the whole long list of hills in this country. One of the first results of such a study is to shake our faith in the truth of the common impression that present ruggedness of surface has some necessary connection with former volcanic eruptions, or that evidence of these eruptions is to be sought for only where the ground is rough and broken. But this impression is so deeply rooted, that it requires no small effort, and not a little acquaintance with facts as they are in nature, before it can be finally cast aside. But cast aside it must be, if we would make any satisfactory progress in physical geology. In no single instance in the British Islands does any hill, formed of rocks of volcanic origin, present still its original outlines. Probably its existence as a *hill* is an event long subsequent to the eruption of its component rocks, and due to a very different cause. Owing to many ups and downs, dislocations, and repeated prolonged wearing away, only a remnant of the erupted material is now to be seen. Hence all our so-called "craters" are deceptive, and take their rise from the unequal erosion of the rocks among which they lie. In like manner the conical outline so often assumed in this country by truly volcanic rocks, arises wholly from the way in which they yield to the wasting influences of nature. The most rugged parts of the British Islands are not volcanic, while some of the most remarkable traces of ancient volcanoes are to be found among corn-fields and gardens, and even under the streets of villages and towns. It is only after a careful study of the structure of the rocks that we at last discover that it is to *denudation*, or the unequal wearing away of the surface of the land, and not to movements from below, that the details of the present configuration of our country are mainly due.

The subject of the present paper is one which, I am well aware, cannot be satisfactorily discussed without ample space and an abundance of illustrations. My object, however, is not to discuss it, but rather to point out its nature, in the hope that some readers may be induced to discuss it practically for themselves in the field. Avoiding detail, therefore, as far as possible, let me endeavour to indicate, first, what volcanic rocks are, and how they are to be detected; and secondly, that we have numerous examples of them in Britain of many different geological ages.

I. All igneous rocks are not necessarily volcanic. In many cases masses of melted matter have been injected from below into the crust of the earth deep beneath the surface. It is only where the erupted material has been thrown out at the surface that it properly takes the name of *volcanic*. Hence in deciphering the geological structure and history of a country care must be taken not to misapply that term. An obvious classification of volcanic rocks is into two divisions:—1. The lava-form series, or those which have cooled down from the state of lava; and 2. The ashy series, or those ejected in the form of loose material, such as stones, cinders, dust, and ashes, which have often accumulated in thick masses both on land and under water. Each group is further subdivided according to the composition or structure of its rocks, but into these details we need not here enter further than to note that varieties of our old lavas are known as *basalt*, *greenstone*, *clinkstone*, *felstone*, or more generally as *trap*; while the ashy series includes *ash* or *trap tuff*, *volcanic breccia*, and *agglomerate*. These rocks may evidently be studied under two very different aspects. They may be viewed either as so many mineral products coming from the depths of the earth's crust, upon the composition of which they may be expected to throw some light; or they may be looked upon as memorials of changes in the geological history of the country. Regarded in the latter light, our first object is to search for evidence that they are truly volcanic, and not merely masses which have been intruded into later rocks and cooled deep below the surface. It is evident that the occurrence of layers of ash or tuff is a sufficient demonstration that the rocks under examination were erupted either under water or in the open air, and must be of volcanic origin. For we cannot conceive of the formation of beds of such loose matter within the crust of the earth. Ash or tuff is usually an easily recognizable rock. It consists of a paste of comminuted trap with more or less intermixture of ordinary sandy or muddy sediment. Sometimes it is nothing more than such a fine paste, but it often contains an admixture of fragments of trap and other rocks varying in size from mere grains up to blocks several feet in diameter. Hence there are gradations from the finest ash, through gravelly tuff and breccia, into the coarsest agglomerate. As a rule, the coarser the material and the less mixed it is with ordinary sediment, the nearer probably does it lie to the original focus of eruption. In many ashes or ashy beds organic remains are abundant, and from these we learn that the volcanic dust was showered down upon the sea, on lakes, or on the land, and there enveloped the remains of plants and animals. When no trace of any ash is to be found, search must be made among the trap-rocks for proof that they were lava-flows, and not masses of melted matter which consolidated far beneath the surface. In the latter case they would not be volcanic, and their geological age might not be fixed, nor would they present the same variety of interest which distinguishes the truly volcanic rocks. If the trap does not occur in an amorphous mass, but is arranged in beds, there is some reason to suspect that it may have been erupted at the surface. If, moreover, the beds are found to differ in structure and texture from each other, this suspicion is considerably strengthened, and if the upper and under portions of a bed present a vesicular slaggy appearance, it may be concluded with tolerable certainty that the bed in question is an old lava-flow. When the trap occurs abundantly, it is usually not by one character, but by a number of convergent proofs that we determine it to be of volcanic origin.

Having satisfied ourselves that the rocks are relics of former volcanic phenomena, it remains to determine their geological age. When we look at a hard black *basalt*, a coarsely crystalline *dolerite*, or dull compact blue *clinkstone*, or a dark glass-like *pitchstone*, we can easily admit that they probably each belong to different eruptions. To one unacquainted, however, with the accuracy of geological research, it may seem well-nigh incredible that we should be able to arrange a true chronological series out of what seems involved from its very nature in hopeless confusion. He may find some difficulty in conceiving how it can be possible to pronounce with confidence that a certain chain of hills of volcanic rocks is older than some other chain; that one special hill in a district is younger than its neighbours; nay, that even one part of a single hill was erupted long ages after the other parts. And yet all this and more can be done very easily and with confidence. Snowdon, for instance, is built up of memorials of volcanoes immensely older than those of the Derbyshire hills; the rocks of the Sidlaw hills of Forfarshire are likewise far more ancient than those of the Lothians; the ashes and traps of Wexford belong to a time vastly anterior to those of Limerick, and the upper portions of Arthur Seat, at Edinburgh, were ejected many a long age after the volcano that gave birth to the lower portions of the hill had become extinct. The determination of these relative dates is really a matter of extreme simplicity. By the well-known geological laws of superposition and organic succession, the age of a group of stratified rocks is fixed, and if such a group contains an intercalated series of volcanic rocks, it is clear that these must belong to the same geological period. Thus in the Snowdon district the stratified rocks contain fossils which show them to be of Lower Silurian age, and hence the trappean rocks interbedded with them must be the products of

Lower Silurian volcanoes. Again, the traps of Limerick are regularly intercalated among the carboniferous limestones, and are consequently of the same age.

II. By thus attending to the geological position of the strata with which a group of volcanic rocks is associated, we learn more or less definitely the era of eruption. And as the result of such an investigation, it is known that there are in the British Islands examples of lavas and ashes of many different ages, from the Lower Silurian up even to Miocene times.

During the accumulation of the vast thickness of the Lower Silurian strata, there were active submarine volcanoes on the site of what is now North Wales; and many of the more noted hills and valleys are formed in great part out of the old lava-streams and showers of ash. Snowdon is a striking example. That mountain is built up of several thousand feet of strata of volcanic ash, mingled especially in the upper part with sandy, calcareous, and argillaceous sediment. It is in truth a colossal monument of long-continued volcanic activity. That the volcanoes of that region were submarine and not terrestrial, is shown by the occurrence of marine fossils in the ashy layers, belonging to well-known species of the Caradoc or Bala rocks. There is evidence that the volcanoes were active in more than one part of the Lower Silurian period. During the accumulation of the Llandeilo flags there was a vigorous group of submarine volcanoes in the district of Cader Idris, Aran Mowddwy, and Arenig Fawr. These died out, and afterwards, when the Bala beds were in the course of formation, the internal igneous forces broke out anew over the region around Snowdon.*

In Ireland, also, between the north of Wicklow and Waterford Harbour, the Lower Silurian series abounds in felstones and ashy beds.

The Old Red Sandstone of Scotland contains a great development of volcanic rocks. They form the chains of the Sidlaw and Ochil Hills, the Pentlands, and other groups. They are felspathic traps, ashes, and conglomerates, forming, by their decomposition, smooth green uplands and detached green conical hills.

Throughout the central valley of Scotland, also, the carboniferous formation is richly charged with traces of contemporaneous igneous rocks. Indeed, during the growth of that formation the lowlands seem to have been dotted over with little

* The reader who wishes to study the volcanic history of North Wales should read the works of Sir R. I. Murchison, and consult the elaborate maps of the Geological Survey, combining the results of long years of patient research by Ramsay, Jukes, Selwyn, Aveline, and other members of the Survey. The descriptive catalogue of the rock specimens in the Jermyn Street Museum will be found also very useful; but the great work on the subject will be Prof. Ramsay's forthcoming Memoir on North Wales.

volcanic cones sending out each its showers of ash or streams of black lava. There are few geological sections more interesting than some of those in the Linlithgowshire hills, where alternations of trap, ash, shale, limestone, and other strata have been laid open. Sometimes, for instance, we find a bed of limestone made up of the stems of encrinites and brachiopod shells, and covered sharply by a layer of ash. The limestone points out a comparatively clear sea-bottom, and in the ash-bed we have proof of a shower of volcanic dust and stones, which covered the bottom, and destroyed the organisms that happened to be living there at the time. In other cases, the upper part of an ash-bed becomes calcareous, and a few straggling shells make their appearance, until the bed passes up into a limestone, showing how, after showers of volcanic detritus, the sea-floor became gradually coated, as before, by a layer of living and dead organisms. There are likewise occasional thin seams of coal, and abundant remains of plants indicative of sub-aerial growth, and over the whole comes usually a bed of amorphous or columnar basalt. These sections are easily visited, and deserve to be better known.

In Derbyshire the carboniferous limestone has long been known to contain certain beds of contemporaneous trap called *toadstone*. In Ireland also there occur, at Limerick and elsewhere, beds of trap and ash intercalated among the limestones of the same formation.

The only Permian traps and ashes yet noticed in the British Islands are those recently described from Ayrshire and Nithsdale.*

Throughout the western region, from Lough Neagh northward by Mull and Eigg to Skye and the Sheant Isles, volcanic rocks play an important part. Much, if not most of the basalt, dolerite and ash of this tract is later than the chalk, and is at once the newest and most extensive mass of volcanic material in the British Islands. It has the great advantage, moreover, of being much better exposed to view than the igneous rocks of any other series. The waves of the Atlantic have carved it into ranges of lofty cliffs which stretch on, league after league, headland after headland, and island after island, for a distance altogether of not much under 250 miles. It forms the well-known scenery of the Giant's Causeway and the Antrim coast-line, Staffa, and the strange terraced pyramidal hills of Mull, and the chain of the inner Hebrides. Much remains to be known about this great development of volcanic rocks. In some places, as in Antrim and the Isle of Mull, fine clay with leaves of trees or layers of lignite have been found intercalated between the sheets of basalt. It seems likely that similar interstratifications must occur elsewhere, and perhaps in such localities, yet to be discovered, further evidence may transpire as to the history of these post-cretaceous volcanoes, and as to their definite geological horizon.

* 'Geol. Mag.' for June, 1866.

In fine, there are few branches of British out-of-door geology in which the student will find more to interest him than in the story of our old volcanoes, or where, by diligent work, he will be more likely to discover new facts, and thus add to the treasures of the science. The apparent repulsiveness of the subject will soon disappear as he enters fully into his self-appointed task; and even if he should content himself with simply treading in the path that has been laid out for him by the laborious footsteps of earlier observers, he will not have spent a week or two in the pursuit without gaining new bodily vigour, and carrying away with him many pleasant memories of the rocks, quarries, and hill-sides among which he was at work.

VI. DE LA RUE AND CELESTIAL PHOTOGRAPHY.

It is about twenty-seven years since we were told of a remarkable discovery, made by a Frenchman, of a process by which external objects were made to delineate themselves on prepared metal plates, placed in a camera-obscura, with a perfection of detail and a delicacy of delineation which had never been approached by the human hand. The pictures so produced by Daguerre were seen and admired. The world of Science, once awakened to the fact, that the Sun's rays could be made to copy, on prepared tablets, the objects which they illuminated, went busily to work investigating the curious phenomena involved in the art of Photography. It must not be forgotten that Wedgwood, assisted by Davy, produced *unstable* photographic pictures in 1803.* Mr. H. Fox Talbot, soon after the announcement of Daguerre's discovery, produced his "Photogenic" drawings, speedily followed by his beautiful "calotype" pictures. Sir John Herschel investigated, with much industry and skill, the chemical changes produced upon organic and inorganic substances by solar agencies; and Mr. Robert Hunt published, in rapid succession, his discoveries of the developing power of the proto-sulphate of iron, of the influence of the chemical rays in accelerating the germination of seeds, his "chromatype," and other processes for producing photographic pictures. Beyond this, at the second meeting of the British Association at York, in 1844, this photographer showed that the chemical changes produced by the sun's rays were not due to their luminous power, but were the consequence of *dark* radiations, for which principle or power he proposed the name of ACTINISM—a term which has been generally adopted.

These researches appeared to confirm the results obtained

* 'Journal of the Royal Institution,' vol. i.

Vincent Brooks, lith

Warren De La Rue

and the hypotheses propounded by M. Berard, in 1812, which were reported upon by Berthollet, Chaptal, and Biot.*

A few years passed away: Professor Schönbein discovered gun-cotton, and at the meeting of the British Association at Southampton, in 1846, he introduced it as an important improvement upon gunpowder. As a destructive agent, gun-cotton has been slow in making its way as an agent for projecting cannon-balls or for rending rocks; but dissolved in ether, it forms that collodion which Mr. Archer, in 1851, taught us how to use in multiplying images of the beautiful, and the process to which it has given its name is now universally adopted, to the almost entire exclusion of every other kind of photographic manipulation.

At a very early period (1838–40), it was seen that the changes produced on the salts of silver by the sun's rays might be used to render meteorological and other instruments self-registering. In 1838, Mr. T. B. Jordan, then secretary of the Royal Cornwall Polytechnic Society, devised and used photographic methods for registering barometers, thermometers, and magnetometers.† These methods, modified by Mr. Brooks and Mr. Ronalds, were subsequently introduced into the observatories at Kew and at Greenwich, where, at the latter especially, under the direction of Professor Airy, a beam of artificial light now registers through each day and night every movement of those steel bars which tell us of the variations in the earth's magnetic intensity, and of the occurrence of the strange phenomena known as "Magnetic Storms," now proved, by the investigations of General Sabine, to be intimately connected with those solar spots which are being explored—if the term is admissible—by Celestial Photography. While photography was making progress as an art, it was employed in a few hands as an aid in scientific investigations. Sir John Herschel especially used chemical compounds, sensitive to solar influences, to determine the relative values of the solar radiations proceeding from different parts of the sun's disc, and this led to the determination of the

* "To show clearly the great disproportion which exists in this respect between the energies of different rays, M. Berard concentrated, by means of a lens, all that part of the spectrum which extends *from the green to the extreme violet*, and he concentrated, by means of another lens, all that portion which extends from the *green to the extremity of the red*. This last pencil formed a point so brilliant that the eyes were scarcely able to endure it, yet the muriate of silver remained exposed more than two hours to this brilliant point of light without undergoing any sensible alteration. On the other hand, when exposed to the other pencil, which was much less bright and less hot, it was blackened in less than six minutes."—"Report of the Commissioners:" 'Annales de Chemie.' See also, "Report on the Chemical Action of Solar Radiations:" 'Transactions of British Association for 1850,' vol. lxxxv., p. 309.

† "On a New Method of Registering the Indications of Meteorological Instruments." By T. B. Jordan. 'Sixth Report of Royal Cornwall Polytechnic Society,' 1838.

fact at the same time, by two distinct observers,* that the chemical action produced by the rays coming from the edge of the sun were less active than those proceeding from its central regions. This fact has been, strangely enough, recently put forward as a discovery by Professor Roscoe,† without the mention of any previous observer, excepting Secchi, whose observations had reference to the calorific, and not to the chemical radiations. It is true that Professor Roscoe has made a series of excellent experimental observations, and that he has proved "that the intensity of the chemically active rays at the centre is from three to five times as great as that at the edge of the disc;" but in doing this he has only confirmed the results already published.‡ For example, in 1840, Sir John Herschel, in the 'Philosophic Transactions' (Part I., p. 43), distinctly stated that he had detected "a real difference between the chemical agencies of those rays which issue from the central portion of the sun's disc, and those which, emanating from its borders, have undergone the absorptive action of a much greater depth of its atmosphere, and yet I confess myself somewhat at a loss what other cause to assign for it. It must suffice, however, to have thrown out the hint, remarking only that I have other, and, I am disposed to think, decisive evidence of the existence of an absorptive solar atmosphere extending beyond the luminous one. The breadth of the border, I should observe, is small, not exceeding 0·5, or one-seventh part of the sun's radius; and this, from the circumstance of the experiment, must necessarily err in excess."

Mr. Robert Hunt, in the 'Philosophical Magazine' already quoted, noticed the same phenomenon, and gave the same, as being the most familiar explanation of it; and subsequently M. Arago, in his 'Memoirs on Photometry,' again drew attention to this important fact.

The results which have been obtained since 1840 appear to show, not merely that the chemical radiations generated near the edge of the solar disc are absorbed in passing through a greater depth of the sun's atmosphere, but that there is an actual *interference* (using this term in its ordinary acceptation rather than its scientific sense) exerted by the luminous radiations, and that the chemical radiations have their origin in a lower zone, that which produces Light-energy. The protected band which is seen to surround the prismatic image of the sun is not due to a lowering

* 'Philosophical Magazine,' vol. xvi., 3rd series, contains an abstract of the memoir read before the Royal Society by Sir John Herschel; and also a paper in the same monthly part of this magazine by Robert Hunt, on "Experiments and Observations on Light which has permeated coloured Media, and on the Chemical Action of the Solar Spectrum," in both of which this fact was, for the first time, stated.

† "On the Measurement of the Chemical Brightness of various Portions of the Sun's Dic." By Henry Enfield Roscoe, B.A., F.R.S. Received June 12, 1863.

‡ See "On the Present State of our Knowledge of the Chemical Action of the Solar Radiations." A report to the British Association, in 1850, by Robert Hunt.

merely of chemical (actinic) intensity, as would be the case if it were an instance of loss by the absorption in the solar atmosphere; but there is evidence of a changed condition, such as is shown by the protected bands observed under the yellow and the red rays, where luminous and calorific power attain their maximum influence. On this point we have yet a few more words to say.

Professor Bond, of Cambridge, with Messrs. Whipple and Black, of Boston, in the United States, were the first to make a photographic picture of any celestial body. This was an image of the moon, obtained upon a Daguerreotype plate, which had been placed in the focus of the refracting telescope of the Harvard Observatory. In 1851, some of these Daguerreotypes of our satellite were in the American department of the Great Exhibition. In 1852, Mr. Warren De la Rue obtained positive lunar photographs, in from ten to thirty seconds, on a collodion film, by means of an equatorially-mounted reflecting telescope of thirteen-inch aperture and ten-feet focal length. At this time Mr. De la Rue had not applied any mechanical driving motion to his telescope. He was therefore constrained to contrive some other means of following the moon's apparent motion. This he accomplished by hand in the first instance, by keeping a lunar crater always on the wire of the finder, by means of the ordinary hand-gear of the telescope, but subsequently by means of a sliding frame fixed on the eye-piece holder, the motion of the slide being adjustable to suit the apparent motion of the moon. As the pictorial image of the moon could be seen through the collodion film, and could be rendered immovable in relation to the collodion plate, by causing one of the craters to remain always in apparent contact with a broad wire, placed in the focus of a compound microscope affixed to the back of a little camera-box which held the plate, this was effective.

Excellent results were obtained under the disadvantages of the want of an automatic driving motion, which proved how perfectly the hand may be made to obey the eye. Mr. Warren De la Rue was admirably aided in his earliest experiments by Mr. Thornthwaite, since it was found impossible to work without the assistance of an experienced coadjutor.

In 1853, Professor John Phillips communicated to the Hull meeting of the British Association the results of his experience in Lunar Photography, and he then exhibited some excellent pictures of our satellite. Mr. Hartnup, of Liverpool, aided by Mr. Crooke and other photographers, took some good pictures of the moon in 1854. Father Secchi, at Rome, Mr. Fry, in Mr. Howell's observatory at Brighton, and Mr. Huggins, now so well known by his application of spectrum analysis to the stars, nebulæ, and comets, also produced lunar pictures. A great extension of Celestial Photography was promised in 1857 by Professor Bond, who applied the process in measuring the distance and angle of position of double stars, and also in determining their magnitude. He succeeded in obtaining pictures of fixed stars down to the 6–7th magnitude, and everything gave promise of a fruitful future, when death put a stop to his labours.

In the same year (1857) Mr. Warren De la Rue was successful in applying a driving motion to his telescope, which answered every purpose desired; and since that time he has unremittingly followed up the subject of Celestial Photography whenever his occupations and the state of the atmosphere permitted it.

The Academy of Sciences of Paris has lately recognized Mr. De la Rue's labours, by the high distinction of the Lalande prize of Astronomy. From the address which was delivered on the occasion of its presentation, many of the following notices have been derived. As the facts thus detailed have all been subjected to the most searching examination, they stand beyond suspicion, and furnish the most reliable record which it is possible to give of the progress which has been made in an inquiry involving the use of the most perfect astronomical instruments, the most delicate physical appliances, and the most sensitive chemical preparations, directed by a zealous and thoughtful mind. It has been by means of an equatorial reflecting telescope of thirteen inches aperture, designed by himself and constructed in his own workshop, that Mr. Warren De la Rue has attained that degree of perfection in Astronomical Photography which has earned for him the gold medal of the Astronomical Society and the Royal medal of the Royal Society.

His splendid photographic delineations of our satellite, with which the scientific world is familiar, owe their excellence, first, to the perfection to which the optical part of the telescope was brought by machinery of his own contrivance; and, secondly, to the remarkable performance of his clockwork-driving apparatus, which not only works smoothly and equably, but is capable of rapid and easy adjustment to the ever-varying velocity of the moon. Mr. De la Rue's chemical training has, moreover, enabled him to secure that nice balance of affinities in his photographic preparations, which has materially reduced the time required to impress the image on the sensitive tablet, and consequently to diminish the bad effects of disturbance of the image, resulting from the unsteadiness of our atmosphere. By these means, pictures of the moon have been repeatedly taken by him in the focus of his reflecting telescope, so perfect as to bear considerable amplification—for example, to thirty-eight inches in diameter. These images admit of measurement with the microscope, so exact as to furnish excellent data for investigations in relation to a supposed physical libration of the moon. These pictures are also now being used as the foundation of the large map of the moon, six feet in diameter, which is being laid down by the Moon Committee of the British Association, as the basis of the intended zone observations of the lunar surface, by the co-operative action of certain English astronomers. The beautiful stereoscopic views of the moon, with which all are familiar, have done much, and are capable of doing more, in throwing light on the configuration of the lunar surface. It is especially the stereoscopic combinations of enlarged pictures which are calculated to impart a correct knowledge of the relative height and depressions of the terraces, undulations, dykes, and furrows of our satellite.

In pursuing his favourite subject Mr. De la Rue has successfully taken pictures of Saturn, Jupiter, and Mars, and of some of the fixed stars. The most valuable, however, of Mr. De la Rue's contributions to Astronomical Photography was the designing of the photo-heliograph of the Kew Observatory, and subsequently of the micrometer used for measuring the solar autographs, so as to bring them under the domain of calculation.

Sir John Herschel suggested that it would conduce greatly to a true knowledge of our luminary if a daily photographic record of the sun's surface were obtained. Acting upon this suggestion, and at the request of the Royal Society, Mr. De la Rue designed the Kew heliograph, which was erected at the Kew Observatory of the British Association in 1858, and has since that time been more or less worked.

In 1860, this heliograph was taken to Spain, at the desire of the Royal Society, and was successfully employed by Mr. De la Rue at Rivabellosa, in obtaining a series of pictures of the solar eclipse of July 18, before, during, and after total obscuration.

In the Bakerian lecture, read before the Royal Society on the 10th of April, 1862, the methods used in measuring these photographs are fully set forth, and the results discussed at length.*

From an early period several peculiar phenomena have been observed during eclipses of the sun, especially just before and after total obscuration. In 1733, Rydhenius, pastor of Forshem, states, "when the sun was about to lose his light, and also when he was about to recover it, *he emitted rays that undulated like the aurora borealis and were of a fiery red colour.*"† Delisle has recorded an observation made in 1738 of the moon's shadow passing upon a wall at the moment of total obscuration—*tinged with different colours*,‡—by whom made we are not informed; and in 1842 some French astronomers, according to Arago,§ observed similar pheno-

* 'Philosophical Transactions for 1862,' vol. clii., p. 333.

† 'Acta Lit. et Scien. Succ.,' tom. iv., p. 61.

‡ 'Mémoires pour servir à l'Histoire et au Progrès de l'Astronomie.' St. Petersburg, 1738.

§ 'Annuaire, 1846,' p. 399.

mena to those just described. In 1836, on the occasion of the annular eclipse of May 15, Mr. Baily noticed a very striking appearance, which he thus describes: "When the cusps of the sun were about 40° asunder, *a row of lucid points like a string of bright beads,* irregular in size and distance from each other, suddenly formed round that part of the circumference of the moon that was about to enter on the sun's disc." The same phenomenon occurred in a reverse order at the dissolution of the annulus. This phenomenon had been observed previously (but never so perfectly described as it was by Mr. Baily*) by Halley in 1715, by Delisle in 1724, by Professor Bayne in 1737, by the Rev. Mr. Irvine in 1748, by Mr. S. Webber in 1791,† and some others. Subsequent to Mr. Baily's observations no opportunity has been lost by astronomers; and other and yet more remarkable phenomena have claimed especial attention. By far the most striking, and we may almost say inexplicable, are the red protuberances which appear on the edge of the sun when all the direct radiations are obscured by the body of the moon.

The earliest notice which we have of those red protuberances beyond that of Rydhenius, already spoken of, is to be found in an account of the total eclipse of 1733, by Vassenius, in the 'Philosophical Transactions of the Royal Society.'‡ Vassenius speaks of them as "some reddish spots which appeared in the lunar atmosphere without the periphery of the moon's disk." These red spots appear to have attracted occasional attention; but it was not until the eclipse of 1842 that any degree of close observation was directed to them. M. Mauvais, who observed this eclipse at Perpignan, described the phenomenon as observed by him. He says, "I cannot give a more exact idea of their aspect than by comparing them to the peaks of the Alps illuminated by the setting sun, and seen afar off."§ M. Mayette, an officer of the French Engineers, compared the protuberances, as seen by him, also from Perpignan, to *beautiful sheaves of flames.* Each observer who has written on this eclipse has described the phenomenon as seen from the several points of observation along the line of totality. Mr. Baily, who was at Pavia, wrote of the luminous protuberances as having the appearance of mountains of a prodigious elevation, the colour of the peach blossom nearly representing their aspect.|| Mr. Airy was near Turin. He remarks that "in form they somewhat resembled saw-teeth in the position proper for a circular saw."¶

M. Littrow, of Vienna, and M. Otto Struve, have given carefully

* 'Memoirs of Astronomical Society,' vol. x., p. 7.
† Consult 'History of Physical Astronomy,' by Robert Grant, F.R.A.S.
‡ 'Philosophical Transactions, 1733,' p. 135.
§ 'Annuaire, 1846,' p. 409.
|| 'Memoirs of Astronomical Society,' vol. xv., p. 6. ¶ Ibid., p. 16.

graphic accounts of these protuberances. They have also been noticed by other astronomers in all parts of the world. Sir John Herschel thus describes them: "Distinct and very conspicuous rose-coloured protuberances were seen to project beyond the dark limb of the moon, likened by some to flames, by others to mountains, but which their enormous magnitude and their faint degree of illumination clearly prove to have been cloudy masses of the most excessive tenuity."*

In 1851, Dr. Busch succeeded in obtaining a Daguerreotype of the total eclipse of that year with the Königsberg heliometer. In this daguerreotype the protuberances were seen, but indifferently defined.

In 1859, Mr. De la Rue commenced making the experiments necessary for securing a favourable photographic result, upon the occurrence of the total eclipse of 1860. The difficulties in the way of this were great. These will be gathered best from Mr. De la Rue's own words: "I made inquiries of those astronomers who had witnessed the eclipse of 1851 respecting the intensity of the light of the corona and red flames as compared with that of the moon, and the relative brightness of one to the other. . . . . The general impression I formed from the information thus derived was, that the light emitted by the corona and red flames taken together was about equal to that of a full moon, less rather than greater; but no one recollected precisely the brightness of the prominences as compared with that of the corona."† Numerous experiments were made, and it was rendered evident that the utmost sensibility must be secured in the collodion plates to leave any hope of photographing those "cloudy masses of the most excessive tenuity." The result of those preliminary experiments was that "nitrate of silver baths, prepared in the ordinary way with crystallized nitrate of silver, were taken and were used in depicting the several phases of the eclipse, with the exception of those of totality. In taking the latter pictures, the baths used were made with nitrate of silver which had been fused carefully in my own laboratory, and were so extremely sensitive that they would give photographs of the full moon in the focus of my reflector in less than a second of time, while with the usual bath five seconds were barely sufficient to give a picture of similar intensity."‡ Thirty-four cwt. of apparatus, made up in thirty packing-cases, were conveyed to Spain in the 'Himalaya,' landed at the port of Bilboa, and thence conveyed to Rivabellosa, a distance of seventy miles, by the ordinary conveyances of the country. Everything was satisfactorily arranged, and "upwards of forty photographs were taken during the eclipse, and a little before and after it, two

* 'Outlines of Astronomy,' edit. 1850, p. 235.

† 'Philosophical Transactions, 1862,' vol. clii., p. 334. ‡ Ibid.

being taken during the totality, on which are depicted the luminous prominences with a precision as to contour and position impossible of attainment by eye observations." Thus was achieved a most important end; and we have secured a record of some peculiar solar energy, or its effects, which will greatly aid us in determining the physical condition of the solar mass, and its enveloping gaseous spheres. For a full and detailed account of the apparatus used, and of the methods adopted, as well as for a graphic description of the eclipse itself, we must refer our readers to the Bakerian lecture already quoted.

In that paper the methods used in measuring the photographs are also fully set forth, and the results discussed at length. It is there shown, by measurement of the positions of the luminous prominences in the totality of pictures obtained at two epochs, one immediately after the disappearance, and the other just before the re-appearance of the sun, that the angular change of position of the luminous prominences with respect to the moon corresponds to the theory of their fixature to the sun;—That the "flames" change only apparently, not really, by the moon's motion over them—that is, as the moon covers one portion and discloses another—and do not otherwise undergo any alteration; so that when the clock, by which the telescope was moved, was adjusted to the sun's motion, the "red flames" stood still. Moreover, it is therein shown by a comparison of the photographic pictures with the optical observations made by Mr. De la Rue at the same time, that luminous prominences invisible to the human eye are depicted in the photographs; thus pointing out and exemplifying by a new experiment the difference which has been frequently shown to exist between the solar, chemical, and luminous radiations.

A curious question arises from the consideration of the chemical power evidently possessed by these prominences, be they flames or clouds. We never, as we have already stated, under ordinary circumstances obtain an impressed image of the sun without finding the indications of a protected circle—that is, one which proves a paucity of chemical power—surrounding the photographic disc. Yet, when the light of the solar disc is interrupted by the body of the moon, the radiations proceeding from the edge, or rather, perhaps, from beyond it, have a strong photographic power. What is the cause of this most remarkable difference? The question can only be answered satisfactorily by waiting for the evidence of future experiments. Those prominences become visible to the eye during an eclipse, because the eye is protected by the moon from the intense glare of solar light. They evidently belong to the sun. This was yet further proved by a careful examination of the photographs of the same eclipse obtained by Padre Secchi. The luminous prominences, due allowance being made for parallax, were identical in both, thus proving that no change takes place in the form of the prominences for a period much longer than the duration of a total eclipse. It must be borne in mind that the eclipse occurred at an interval of seven minutes between Rivabellosa, where Mr. De la Rue was stationed, and Desierto de las Palmas, where Padre Secchi was located.* Now, why is it that the photographic tablet is impressed by those attenuated images during an eclipse—and even by such of them as do not give light enough to the visible at the period of totality—and that they do not effect the required chemical change upon our sensitive plates when the sun is unobscured? The only reply which we are at present in a position to give is, that the diffused light when the sun is shining is sufficiently powerful to overcome the weaker chemical radiations of those solar clouds or flames. If this reply approaches correctness, we have additional evidence confirming the view that the two principles existing in the sun-beam, *light* or luminous power, and *actinism* or chemical power, are not modifications of the same *energy*—to use the accepted term of the day—but rather forces balanced against each other, acting indeed in antagonism. That the luminous rays have the power of entirely subduing the chemical rays has been shown by several experiments by Sir John Herschel † and others.

Referring to the 'Report on Celestial Photography in England, 1859,' we find full confirmation of these views. "Portions of the moon, equally bright optically, are by no means equally bright chemically; hence the light and shade in a photograph do not correspond in all cases with the light and shade in the optical picture. Photography thus frequently renders details visible which escape observation optically, and it therefore holds out a promise of a fertile future in selenological researches; for instance, strata of different composition evidently reflect the chemical rays to a greater or less extent, according to their nature, and may be thus distinguished. The lunar surface very near the dark limb is copied photographically with great difficulty, and it sometimes requires an exposure five or six times as long to bring out completely those portions illuminated by a very oblique ray, as others apparently not brighter but more favourably illuminated. The high ground in the southern hemisphere of the moon is more easily copied than the low ground, usually called seas, which abound in the northern hemisphere. From these circumstances, I ventured in another place ('Monthly Notices of Astronomical Society') to suggest, that the

* "Comparison of Mr. De la Rue's and Padre Secchi's Eclipse Photographs." By Warren De la Rue, F.R.S.—'Proceedings of the Royal Society,' vol. xiii, p. 442.

† "Memoir on the Chemical Action of the Rays of the Solar Spectrum."—'Philosophical Transactions, 1840.'

moon may have an atmosphere of great density, but of very small extent, and that the so-called seas might be covered with vegetation."*

In 1853, Professor John Phillips indeed noticed this difference between the visual and the actinic brightness of portions of the lunar surface.†

The application of photography to the planets by Mr. Warren De la Rue and others confirms this fact. For example, the occultation of Jupiter by the moon on November 8th, 1856, afforded an excellent opportunity for comparing the relative brightness of our satellite and that planet. On that occasion, Jupiter appeared of a pale greenish tinge, not brighter than the crater Plato, and according to Mr. De la Rue's estimate, of about one-third the general brilliancy of the moon; but the actinic power was subsequently found to be equal to fully four-sixths or five-sixths of that of the moon. "Saturn," says the same observer, "required twelve times as long as Jupiter to produce a photograph of equal intensity, on an occasion specially favourable to making the experiment; yet I obtained a picture of Saturn together with that of the moon in fifteen seconds on May the 8th of the present year (1859), just as the planet emerged from behind the moon's disc. The picture of the planet, although faint, is sufficiently distinct to bear enlarging."

Jupiter, Mars, and Saturn, together with several of the fixed stars, have been photographed; but the promise afforded by these chemical pictures is not of that high character which belongs to those of our satellite. Studying the large picture of the moon, hanging in the Royal Society's room, which has been produced by the aid of photography, we cannot but feel that we have a wonderfully minute representation of the lunar surface before us. We see, and we can measure the heights of her mountains and the depths of her valleys. Her coasts and cliffs, against which we cannot but think an ocean has at one time beaten its waters, are readily determined. We cannot mistake the craters of eruption, and we are puzzled with such as we must call craters of upheaval, vast swellings, the result of some mighty power which was yet insufficient to burst the stony bubble. Precipices so vast that darkness reigns in the profound depths over which they rise, and glens which appear indeed resigned to all the influences which superstition crowds into such weird gloom are there. Can we not trace glacial moraines? But to what are we to refer the mysterious streaks of light which flow from some of the lunar mountains? We cannot but hope, seeing how much has been done, that we shall have continuous photographic records of the moon's surface. We may then expect to have a more exact knowledge of that lovely orb which belongs especially to our Earth,

* 'Transactions of British Association, 1859,' p. 145.
† Ibid., 1853. 'Transactions of Sections,' p. 16.

and which is therefore of no common interest to the inquiring mind.

Upon the occasion of Mr. De la Rue's visit to Rome, an attempt was made, as a secondary object, by comparing the distances of the moon's and sun's centres with the tabular places, to ascertain whether any correction was necessary to the sun and moon's tabular diameters; and it was found that the latter were in excess of the observed diameters. The correction assigned to the moon's radius from two sets of the observations has been recently computed to be 2″·15, which agrees closely with the correction Mr. Airy has found to be necessary from M. Breins' reductions of forty years' observations of disappearances and reappearances of stars at the moon's dark limb during occultations.*

From 1860 to the present time, the observations by the Kew heliograph have been placed by the Council of the Royal Society under Mr. De la Rue's direction. From February, 1862, to February, 1863, the instrument was removed to the Observatory at Cranford, but a qualified assistant having been trained for the Kew Observatory during that interval, it has been worked continuously at that establishment from May, 1863, until the present time.

The object in view is, of course, to obtain the most perfect record possible of all the physical changes which take place on the sun. "The progress of science," says Mr. De la Rue,† "has hitherto only shrouded in deeper mystery than ever the origin of that wonderful outpouring of light and heat which is the sun's most prominent characteristic; and to this very day it has not been finally decided whether this luminosity proceeds from the sun's solid body, or from an envelope which surrounds it. Indeed, so strange and so unaccountable are many of the features presented to us, not only by our own sun, but by many of the stars, that it has even been conjectured that these bodies exhibit instances of the operation of forces, of the nature of which we are yet ignorant. If we accept this view of the case, the study of our luminary becomes one of very great importance, but one in which we must be very careful to be guided by observation alone. We must obtain numerous and accurate representations of the sun's surface, and study these carefully and minutely before we attempt to generalize."

In the 'Researches' from which we have quoted, we find recorded no less than 631 groups of solar spots, which have been photographed at the Kew Observatory from March 11, 1858, to December 31, 1864. The value of such a continuous record as this can only be thoroughly understood by those who have given some

* 'Monthly Notices of Astronomical Society,' vol. xxv., p. 264.

† 'Researches on Solar Physics.' By Warren De la Rue, F.R.S., Balfour Stewart, F.R.S., and Benjamin Loewy. (First Series, "On the Nature of Sun Spots.")

careful attention to this class of phenomena. This is not the place to discuss the questions which have arisen with regard to the nature of solar spots. Still it is important that a general idea should be given of the conclusions to which Mr. De la Rue and other astronomers have arrived with respect to them.

It was first stated by Dr. Alexander Wilson, of Glasgow, in 1773, that certain phenomena appeared to indicate that spots are cavities in a luminous photosphere which surrounds the sun. Mr. Dawes has shown that we have often connected with the same phenomenon—the formation of a sun spot—not less than five degrees of luminosity:—1. The faculæ, or bright streaks of irregular direction; 2. The ordinary photosphere; the *luminous* envelope of the sun; 3. The penumbra, or shaded portion of a spot.; 4. The borders of the umbra; and 5, the very dark central nucleus. The term *umbra* is used by Mr. Dawes to denote a region of a spot intermediate in darkness between the nucleus and that designated as usual by the term *penumbra.*

It should be understood that the photographs of the solar surface show with great distinctness those five degrees of illumination. Indeed, these are so decidedly delineated on the collodion tablet, that by calling in the aid of the electrotype process Mr. De la Rue has been enabled to obtain plates, from which any moderate number of copies can be printed off.

The Kew photographs have already confirmed the results of some previous observations, and established some new and important facts. We have only space to state these as concisely as possible.

1. These photographs prove the central portion of the solar disc to possess a higher degree of luminosity than the borders.

2. They have shown that the *umbra* of a spot is nearer to the sun's centre than the *penumbra.* That is, it is at a lower level. The solar spots are, therefore, cavities in the photosphere.

3. It appears fair to conclude from the examination of all the sun pictures in which the *faculæ* are copied, that "Solar faculæ consist of solid or liquid bodies of a greater or less magnitude, either slowly sinking or suspended *in æquilibrio* in a gaseous medium."

Another paragraph must, from its importance, be quoted—"The idea that faculæ are portions of the photosphere raised above the general surface, appears to be confirmed by stereoscopic pictures of spots obtained by Mr. De la Rue, where the faculæ appear as elevated ridges surrounding the spots. Accepting this conclusion, we next remark that faculæ often retain the same appearance for several days together, as if their matter were capable of remaining suspended for some time."

The deductions to be drawn from a careful study of those solar autographs are, that the lower parts of a solar spot are of a lower temperature than the photosphere in which it is formed. Whether this is due, as some suppose, to the lower temperature of the body of the sun, or to matter coming from a colder region, as is more generally thought, remains yet to be determined.

Chacornac and Lockyer have recorded observations, on the behaviour of the matter surrounding a spot, which appear to suggest the existence of a downward current, which is, therefore, a current from the colder regions above. The faculæ in the larger number of examples fall behind the spots. This appears to suggest an ascending current carrying the hot matter behind. Thus possibly two currents are concerned in the formation of a sun spot; if so, assimilating them to our terrestrial cyclones, which in many other respects they resemble.

The importance and the extension of this system of continuous observation must be evident to all; and it is satisfactory to know that a second heliograph has been made under Mr. De la Rue's direction for the Russian Government, which is now erected at Wilna, the director of that observatory, Dr. Sabler, having received instruction at Mr. De la Rue's observatory at Cranford.

On several occasions, at the Astronomical Society, Mr. Warren De la Rue has pointed out the advantages which will be derived from the use of photographic apparatus for recording future transits of Venus. In the words of the address on the presentation of the Lalande prize, we may bring our notice of Celestial Photography to a conclusion:—"By his own example, by giving instruction to others who desired it, and by continuous observations of his own, Mr. Warren De la Rue has been untiring in promoting astronomical photography; and it may be safely claimed for him that the bringing of this branch of science within the domain of calculation, marks a new era in practical astronomy."

VII. GEOLOGICAL MAPS: THEIR RELATION TO AGRICULTURE AND COAL SUPPLY.

1. *A Geological Map of England and Wales.* By G. B. Greenough, Esq., F.R.S. (on the basis of the Original Map of William Smith, 1815). New edition, revised and improved, under the superintendence of a Committee of the Geological Society of London, from the Maps of the Geological Survey of Great Britain, 1836–63, and Maps and Documents contributed by Sir R. I. Murchison, Professor Phillips, Joseph Prestwich, R. A. C. Godwin-Austen, and others. Six sheets. Scale, nearly six miles to one inch. Published by the Geological Society, July, 1865.
2. *Geological Map of England and Wales.* By Andrew C. Ramsay. Third edition. One sheet. Scale, twelve miles to one inch. London: Stanford, 1866.
3. *First Sketch of a new Geological Map of Scotland.* By Sir R. I. Murchison, Bart., K.C.B., F.R.S., and Archibald Geikie, F.R.S.E., F.G.S. One sheet. Scale, twenty-five miles to one inch. London, 1861.
4. *General Map of Ireland, to accompany the Report of the Railway Commissioners, showing the principal Physical Features and Geological Structure.* Geologically Coloured by Sir R. J. Griffith, Bart., LL.D., in 1855. Six sheets. Scale, four miles to one inch. London and Dublin.
5. *Geological Map of Ireland, to accompany the Instructions to Valuators appointed under the 15th and 16th Vic., cap.* 63. Reduced from the large map of 1855. Scale, about seventeen miles to one inch.
6. *The Geology of the Country round Stockport, Macclesfield, Congleton, and Leek. Explanatory of Quarter Sheets,* 81 *N.W. and S.W. of the Map of the Geological Survey of Great Britain.* By Edward Hull, B.A., F.G.S., and A. H. Green, M.A., F.G.S. London, 1866.

That geological maps are often puzzles to the public is not wonderful; but that they are sometimes a source of discussion to men of science* is much to be deprecated. If, at the outset, we endeavour to answer comprehensively the question, What is a geological map? we are met with some considerable difficulties, and we can only pretend to do so in accordance with the practice of our geological surveyors, and not with what we conceive to be the fundamental principle of the subject.

* See 'Reader,' March 31, 1866.

A geological map of any given district ought to be as nearly as possible a faithful representation of the outlines and superficial extent of those rock-formations which occur nearest to the surface in that area—the vegetable soil being disregarded. But in practice we generally find that the geologists disregard, not only the vegetable soil, but an important series of "detrital" or "superficial" deposits which overlie and mask the more regularly stratified formations. It therefore becomes interesting to ascertain why this should be the case, and for what reason these so-called "superficial deposits" should be treated as something differing in kind from the rest of the rock-masses which form the crust of the globe.

From a scientific point of view, it is easy to draw one great distinction between the "drift" or "superficial" deposits and other formations—namely, that whereas the latter generally conform to certain general rules of dip, strike, &c., and bear a more or less definite relation to the strata above and below them, the latter are altogether irregular in their occurrence, distribution, and inclination. Doubtless exceptions may be quoted which would appear to disprove the correctness of even this wide distinction; but we are inclined to think that it is, nevertheless, correct in so far as it expresses a broad general fact. This being the case, it is certainly much easier to map the formations older than the glacial period than the glacial deposits, and the sands and gravels of more recent date. There is also no question that the distribution of the regularly stratified formations possesses a much higher scientific interest than that of gravel and other drift-deposits, which are of more or less uncertain age, and which are chiefly characterized by occurring anyhow.

From an economic point of view it is not quite so easy to pronounce in favour of one plan to the exclusion of another; but we think that the farmers of England have as great a right to the consideration of the Director-General of the Geological Survey as the miners and the geologists; in other words, it is expedient that the gravels and drifts should be mapped with the same care as the older formations, and more especially in districts which do not yield valuable minerals. A farmer who knows that some of his land has a gravelly subsoil, and the rest a clayey, wishes to ascertain the boundary-lines of the two deposits. To tell him that the clay is London clay, and is only irregularly covered by the post-glacial gravel, is to give him information that he neither requires nor understands, and to ascertain which he would never spend a sixpence. We believe that this fact has of late been recognized by the directors of the Geological Survey, and the more recently published sheets of the survey-map of Great Britain contain either delineations or indications of the outcrops of the superficial deposits.

Fortunately for the farmers, they have a powerful ally in the opacity of even superficial formations; and the reflecting geologist is no doubt often staggered at the hardihood of surveyors who draw a wriggling line of outcrop to a stratum which is known to be buried fifty, a hundred, or more feet beneath drift-deposits, and beyond the ken of mortal men.

Much may be said, no doubt, on the part of the surveyors, who, to do them justice, are really not in the habit of mapping the outcrops of strata without some tangible warrant for so doing. If a given series of beds is observed where properly exposed to "behave" in a particular manner towards those above and below them, and towards the "form of the ground," it is reasonable to infer that they will do the same at a short distance, although they may not there be seen at the surface. Thus the geological surveyor has to take note of the most trivial circumstances that may be within the reach of observation, so as to decide for future guidance what phenomena are general and what accidental. In this manner, a roadside bank speaks volumes, and a ditch reveals wonders, while a railway-cutting affords an opportunity of luxurious surveying, which ought to stimulate the surveyor to take a sanguine view of the prospects of all projected lines.

After all, the fact remains, that perhaps the greatest desideratum in British geology is a good map of the surface-deposits of the United Kingdom. We have several first-rate geological maps (in the ordinary sense) of England and Wales, and of them all, the most generally useful is no doubt Professor Ramsay's beautiful sheet, the geology of the new edition of which is much improved, while the actual and ideal sections have required no change. The new edition of the Greenough Geological Map is probably the most accurate yet published, so far as the wretched topography of most of it will allow of geological precision; indeed, it embodies the whole of the information in the possession of the Geological Survey, and the Council of the Geological Society, almost up to the date of publication; at any rate, that portion of it which was considered sufficiently authentic to be published.

The only reliable geological map of Scotland, at present in existence, is the small one by Sir R. I. Murchison and Mr. Geikie; that is to say, if the views held by the great majority of geologists, in opposition to Professor Nicol, are correct. This map leaves very little to be desired except surface-geology and a larger scale; and we hope that when a new edition is called for, the scale will be increased. Of Ireland, the old map of Sir Richard Griffith and the small reduction of it still remain the best; but we hope they will soon be superseded by a map compiled by one of the officers of the Irish Survey, for that survey must necessarily have modified our knowledge of the distribution and limits of the several geological formations in that island.

Returning to the geological maps of England and Wales, it is noticeable that if we compare the more recent with the older editions, we shall find Sir Roderick Murchison's view of the Permian age of the St. Bee's and Corby sandstones adopted both by the Council of the Geological Society and by Professor Ramsay. This is a matter of practical as well as scientific importance; for if these sandstones be of Permian instead of Triassic age, the chance of coal occurring at a reasonable depth beneath them is very much increased, more especially as the Coal-measures themselves crop out and are extensively worked at Whitehaven, immediately to the north.

The question of coal-supply, by the way, appears at last to be attracting the attention of public men; but whether any practical result will flow from this revived interest appears more than doubtful. There are many considerations respecting the supply and consumption of coal, to which Mr. Jevons did not attach sufficient weight, and which would cause us to measure England's period of commercial supremacy more favourably than that author. Nevertheless, there is sufficient cause for our striving to answer the question—By what means can we put off the day when our manufactures will cease to be able to compete with those of cotton- and iron-producing countries? That things must come to that pass sooner or later is logically certain, and American manufactures *may* be able to compete with ours much sooner than we expect.

Closely connected with this inquiry, though not a matter of such vital importance to the nation, is the probable duration of our coal-fields; and in this view it is that the determination of those new districts where coal may still be wrought at moderate depths becomes such an important element in the solution of the problem. That the latent abundance of coal will not of itself ensure our commercial supremacy is sufficiently demonstrated by the present condition of America. The consideration of most consequence is the price at which the coal can be produced, and the relative abundance or scarcity is only one out of several elements which *together* determine the price.

Facts are not wanting which tend to show that the area of our coal-fields will probably be very much increased within a few years. We have already mentioned one case of such a probable extension, and it may be worth while to give another, which is the present result of an attempt to ascertain whether workable coal-seams occur at moderate depths beneath the Lower Permian and Triassic sandstones bordering the Poynton coal-field. This attempt is described by Mr. Hull in the memoir illustrating the quarter-sheets 81 N.W. and 81 S.W. of the Geological Survey-map of Great Britain; and he states that a seam of coal three feet in thickness, and unknown in the Poynton district, was passed through by driving a horizontal tunnel from the Park pit at a depth of 200 yards from the surface; "beyond this, Coal-measure shales and clays with *Stigmaria* were proved, and the tunnel was left off in a reddish grit, similar to those found in the Coal-measures of Denton and Hyde."

It is from private enterprizes of this nature that the area of our workable coal-seams will become extended as the geological surveyors make us acquainted with the exact structure of the districts bordering our known coal-fields; but there is a more speculative kind of "prospecting" which we venture to think is a more fit, though a much more novel, subject for national expenditure than a great many others, including even expeditions to the North Pole. We refer to the probability of coal existing at no enormous depth beneath the Tertiary and Cretaceous deposits of the south-east of England, just as it is known to do beneath the chalk of Valenciennes, where it has been extensively worked; and of Calais, where it has been reached by borings. Geologists have even mapped the probable direction and extent of the subterranean prolongation of one of our great coal-fields; but opinions are divided as to the particular English coal-field with which the French (and therefore also the hypothetical London) field is connected. Mr. Godwin-Austen, who first started the notion of a London coal-field, considers it to be connected with the South Welsh and Midland coal-basins; but others hold the balance of probabilities to be in favour of the Northern coal-field. It would cost the nation comparatively little to demonstrate, by boring, the correctness or error of one or both of these views; and if coal were won, the expense might easily be defrayed, and a large source of revenue created, by a tax on the consequent yield.

VIII.—ON A TEMPORARY OUTBURST OF LIGHT IN A STAR IN CORONA BOREALIS.

By William Huggins, F.R.S.

Occasionally, but at rather long intervals, men have been startled by the extraordinary spectacle of the sudden appearance of a brilliant star in a part of the heavens where before no star was to be seen.

During the first seventeen centuries of the present era, perhaps eight or nine of these strange visitants astonished the world. It is probable that many of the objects in the Chinese catalogue of Matuan-lin are not stars, but, as their observed motion appears to show, trainless comets. If we add those in this catalogue which may be supposed to be new stars, perhaps altogether about twenty of these remarkable objects have been recorded during the last two thousand years. Since 1670, no new star of sufficient splendour to attract general attention has appeared. On April 28, 1848, Mr. Hind discovered a star of between the 4th and 5th magnitude, occupying a position in Ophiuchus, where previously no star even of the 9·5 magnitude could be seen. This star has not disappeared, but remains of about the 11th magnitude.

The splendour of all these objects was temporary only. In a few days, or weeks, or months, they had waned to a great degree of faintness, and were supposed to have become extinct. Whether they really ceased to exist, or merely became invisible to the naked eye, appears to be uncertain.

For centuries the intensely interesting questions have agitated the minds of the more thoughtful of mankind. What are these strange objects? To what cause can the great but very transitory splendour of these stars be ascribed? Are they new creations, celestial ephemeræ, born to die? Are these *new stars* merely the more remarkable and extreme examples of the large class of stars which wax and wane in accordance with a special period of variation?

Tycho Brahe had the good fortune to witness the apparition of the most brilliant of these objects, the celebrated star of 1572. This star, when it first appeared, surpassed in brilliancy Sirius, Vega, and Jupiter, and could be compared alone to Venus when nearest to the earth; within seventeen months the star had become invisible to the naked eye. Telescopes had not yet been invented.

The star of 1604, at its first appearance, surpassed the stars of the first magnitude, and also Mars, Jupiter, and Saturn; but Kepler considered that it was not equal in brilliancy to Venus. This star became invisible after about fifteen months.

Tycho Brahe believed that the star of 1572 had been formed by the agglomeration and condensation of a portion of the nebulous matter diffused through the universe. The Aristotelic philosophy, which then swayed men's minds, prevented the reception of a theory which was not in accordance with the absolute perfection of the heavens. The phenomena of the sudden splendour and rapid waning of these stars were sought to be explained on the supposition that no real change occurs in the star, but that it suddenly advances towards the earth with extreme rapidity, and then retraces its steps until it vanishes in the remotely distant region from which it had emerged. No words are needed, now that the velocity of light is known, to show that this hypothesis must be rejected.

Riccioli, in 1651, extended the Chaldean hypothesis of the moon to the temporary stars, and suggested that these objects may be luminous on one side only. The variation in their brilliancy might, he supposed, be produced by a rotation about an axis. The intermittent light of some of our modern lighthouses may be mentioned as an illustration of this theory. Riccioli added, "When the Deity wishes to exhibit to mankind any extraordinary sign, he makes one of these stars turn rapidly upon its axis."

In modern days the opinion seems to have been growing that the *new* stars of history may be the periodic maxima of permanent but extremely variable stars. M. H. Goldschmidt has brought together reasons to show that the *new* stars of A.D. 393, 827, 1203, and 1609 were probably periodic outbursts of light in one and the same star.

In a recent work of considerable interest,* Dr. J. C. Zöllner endeavours to explain the phenomena of the heavens in accordance with the hypothesis of a nebulous origin of the universe. He supposes that a fiery mass in the process of cooling would become surrounded with a crust of cooled matter. He conceives further that the sudden bursting of this external crust and the outflow of glowing matter from within might present appearances not unlike those furnished by the temporary stars.

Thanks to the researches of Kirchhoff and others we now possess a method of analyzing the nature of a distant source of light, which, it might be expected, would give to us some information of the true condition of the enormous changes which must be taking place in these stars of ephemeral lustre. The observations of the writer and his distinguished colleague, Dr. W. A. Miller, have shown that matter of a nature common to that of our system, and subject to physical laws similar to those which prevail on the earth, exists throughout the stellar host. It was therefore to be expected that the phenomena of the temporary stars were due to physical changes, of which the precise nature might be revealed by prismatic examination.

It has been the good fortune of the writer, conjointly with Dr. W. A. Miller, to examine the spectrum of a bright star, which during the past month suddenly burst forth in the constellation of the Northern Crown.

The sudden outburst of light in this star appears to have been first seen by Mr. John Birmingham, of Tuam, on the 12th of May. In a letter to the writer, Mr. Birmingham describes the star as appearing on that evening "very brilliant, of about the 2nd magnitude, certainly more brilliant than α Coronæ."

* 'Photometrische Untersuchungen mit besonderer Rücksicht auf die Physische Beschaffenheit der Himmelskörper.' Leipsig, 1865.

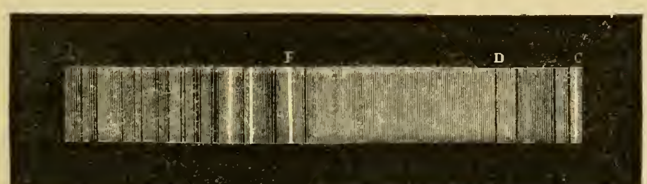
The next evening, the 13th, the star was seen by M. Courbebaisse, at Rochefort, France. On the 11th, this observer had not noticed any new star in the Crown. On the 14th it was observed in Canada by Mr. W. Barker. It was then of the 3rd magnitude. The star was again independently discovered by Mr. Baxendell, on the 15th, at Manchester.

On the 16th, the writer received a letter from Mr. Baxendell, in which he describes the star as "about somewhat less than a degree distant from ε Coronæ, in a south-easterly direction, and last night was fully equal in brilliancy to β Serpentis, or γ Herculis, both stars of about the 3rd magnitude."

On the same evening, the 16th, the writer and Dr. W. A. Miller commenced a prismatic examination of its light.

The star was then below the third magnitude, but brighter than ε Coronæ. In the telescope it was surrounded with a faint nebulous haze, extending to a considerable distance, and gradually fading away at the boundary. A comparative examination of neighbouring stars showed that this nebulosity really existed about the star. On the 17th, this nebulosity was suspected only; on the 19th and 21st, it was not seen.

When the spectroscope was placed on the telescope, the light of this new star formed a spectrum unlike that of any celestial body hitherto examined by them. The light of the star is compound, and has emanated from two different sources. Each light forms its own spectrum. In the instrument these spectra appear superposed. The principal spectrum is analogous to that of the sun, and is evidently formed by the light of an incandescent solid or liquid photosphere, which has suffered absorption by the vapours of an envelope cooler than itself. The second spectrum consists of a few bright lines, which indicate that the light represented by it was emitted by matter in the state of luminous gas. These spectra are represented with considerable approximative accuracy in the following diagram.



Spectrum of absorption, and spectrum of bright lines forming the compound spectrum of a new star near to ε Coronæ Borealis.

From this diagram the reader will notice at the red end of the spectrum a little more refrangible than Fraunhofer's C, two strong dark lines; between these and a line a little less refrangible than D, are a number of fine lines very near each other. About the place of solar D is a less strongly-marked line, and between that and the position of *b* in the solar spectrum there are numerous faint thin lines of absorption. Beyond *b*, as far as the spectrum can be traced, are close groups of strong lines. This is the spectrum of the light of the photosphere interrupted by the special absorption of the cooler vapours which surround it.

The spectrum of the light from a *gaseous* source consists of fine bright lines. These appear in the instrument, as they are represented in the diagram, as if superposed upon the spectrum already described. The brightest of these lines was found by micrometric measures to coincide with Fraunhofer's F. On the 17th, this line was found by a simultaneous observation of it, with the lines of hydrogen, to agree exactly in position with the middle of the expanded line of hydrogen in the green. Another bright line occurs in the red, and appears to coincide with solar C and the red line of hydrogen.

There are two bright lines more refrangible than F, and a fifth line was seen by glimpses near G of the solar spectrum. This may possibly coincide with the blue line of hydrogen.

The compound spectrum of the rapidly waning star was observed on several evenings up to May 28th. No important changes were noticed. From the 16th to the 20th the spectrum from the photosphere appeared to fade more rapidly than the bright lines from the gaseous source.

The position of the groups of dark lines shows that the light of the photosphere, after passing through the absorbent atmosphere, is yellow. The light, however, of the green and blue bright lines makes up to some extent for the green and blue rays (of other refrangibilities) which have been stopped by absorption. To the eye, therefore, the star appears nearly white. However, as the star flickers, there may be noticed an occasional preponderance of yellow or blue. Mr. Baxendell, without knowing the results of prismatic analysis, describes the impression he received to be "as if the yellow of the star were seen through an overlying film of a blue tint."

These observations, with the prism, enable us to form the following conclusions respecting the constitution of this remarkable star. There must be a photosphere of matter in the solid or liquid state emitting light of all refrangibilities. Surrounding this must exist also an atmosphere of cooler vapours, which give rise by absorption to the groups of dark lines.

Besides this constitution, which it possesses in common with the sun and the stars, there must exist the source of the gaseous spectrum. That this is not produced by the faint nebulosity seen about the star is evident by the brightness of the lines, and the circumstance that they do not extend in the instrument beyond the boundaries of the continuous spectrum. The gaseous mass, from which this light emanates, must be at a much higher temperature than the photosphere of the star, otherwise it would appear impossible to explain the great brilliancy of the lines compared with the corresponding parts of the continuous spectrum of the photosphere. The position of two of the bright lines suggests that this gas may consist chiefly of hydrogen.

If, however, hydrogen be really the source of some of the bright lines, the conditions under which the gas emits the light must be different from those to which it has been submitted in terrestrial observations; for it is well known that the line of hydrogen in the green is fainter and more expanded than the brilliant red line which characterizes the spectrum of this gas. On the other hand, the strong absorption indicated by the line F of the solar spectrum, and the still stronger corresponding lines in some stars, would indicate that under suitable conditions hydrogen may emit a strong luminous radiation of this refrangibility.

When the information received from spectrum analysis is considered in connection with the sudden outburst of light in the star, and its rapid decline in brightness from between the second and third magnitude down to the eighth magnitude in about twelve days, the bold speculation presents itself that the star has become suddenly enveloped in flames. In consequence of some great convulsion, on the precise nature of which it would be idle to speculate, enormous quantities of gas have been set free. A principal part of this gas consists of hydrogen, and this is burning about the star by combination with some other element. This flaming gas emits the light represented by the spectrum of bright lines. The spectrum of the other part of the star's light shows that this fierce gaseous conflagration has heated to vivid incandescence the solid matter of the photosphere. The writer regrets much that he had not the opportunity of examining the spectrum of the light of this star at an earlier period. It would be of importance to know whether, at the first outburst, the bright lines of the gas only would have been seen. Some little time would appear to be necessary for the photosphere to acquire the temperature necessary for incandescence.

As the free hydrogen becomes exhausted, the flames abate, the incandescence of the photosphere becomes less vivid, and the star rapidly wanes.

We must not forget that light, though a messenger swift of wing, requires time to traverse celestial space. The great physical convulsion, of which we have been the spectators, is already a matter of history in the case of the star itself. The star has been for years (for ages?) in the enjoyment of the new conditions which this fiery catastrophe has originated.

An important question remains, Is the star really *new?* The Astronomer Royal informs the writer that meridian observations of this star at Greenwich show that its position agrees precisely with a star observed by Argelander of the 9·5 magnitude. Sir John Herschel has informed the writer, that on June 9th, 1842, he saw a star of the 6th magnitude in a position in Corona nearly the same as that of this new star. As the place of the star was laid down merely by naked eye allineations, the object seen by Sir John Herschel may possibly have been the same star during a former similar outburst of light.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

The gradual decline of the cattle plague during the past quarter has amply justified those measures of repression and restriction which had been enacted at the date of our last publication, and to which we then alluded. The latest report of the Commissioners appointed to investigate the subject points out that, up to the date of the Act which authorized the compulsory slaughter of infected cattle, the fatality of the disease was constantly increasing; but that, after that date, it at once commenced a continual decline which has since been almost regularly maintained. This diminution has not only been coincident with the action of the new restrictive measures, but runs a course closely parallel to the operation of the most important of those measures—compulsory slaughter. "Rigid and systematic means of disinfection," "unsparing strictness and unremitting watchfulness," will alone, in the opinion of the Commissioners, be sufficient to extirpate the disease, and when these measures have been successful, there will still remain the duty of guarding against its re-introduction. A few cases have been reported in the north of Ireland; but the rigid isolation of the infected spot appears hitherto to have prevented its extension there. The liability to its re-importation is, however, strikingly illustrated by the Irish experience, and this will, we fear, necessitate a constant and increasingly careful inspection at all those points of debarkation at which we now receive our supplies of foreign cattle. This, combined with either quarantine or immediate slaughter, will be necessary; for the complete investigation of the subject, which a quarter of a million of cases has forced upon us, only deepens the conviction that no remedy exists for the malady when once the poison has been received. The Commissioners inform us that all forms of medicinal treatment have been equally successful, and all have been equally unsuccessful. The regulation of diet has, however, been serviceable—"judicious feeding with soft mashes of digestible food has tended to increase the proportion of recoveries. And it is a noteworthy circumstance, that the proportion of recoveries is larger in the case of small herds than in that of large flocks, thus pointing out how much may be done by careful nursing and individual attention." "Among cottagers' cattle, generally fed on mashed food, the recoveries were 73 per cent.; in large stocks, where dry food has been given during convalescence, the recoveries were 57 per cent.; with mixed food of mashes and hay, they were 22 per cent.; while, among cattle fed entirely with dry food, and treated medicinally with drugs, the recoveries were but 13 per cent." These results were gathered out of the history of 503 cases, of which 191, or nearly 38 per cent. on the whole, recovered. We add that the returns published on June 1st intimate that 244,455 cases, in all, had occurred up till that date, of which 1,207 were reported during the previous week; the weekly numbers having been sinking very rapidly indeed since the month of March, when the number of attacks amounted in one week to as many as 18,000.

The number of animals hitherto reported as having died or been slaughtered does not much exceed 200,000 of all ages, or barely 5 per cent. of the number which recently published statistics declare to be the present cattle population of Great Britain; but the losses have no doubt been greater on the whole than the Government returns declare; and there is this especial aggravation of their severity, that they have not been evenly spread over the country, but have fallen with destructive effect on particular counties. In Cheshire, for example, which is almost exclusively a dairy county, no fewer than 4,800 places have been visited by the plague. In these places there were 90,434 cattle, of which 60,574 have been attacked, and upwards of 50,000 of them are dead. The quiet arithmetical view of the subject as a national loss, which a mere statist may be disposed to take, thus altogether ignores the almost absolute ruin which has befallen individual localities and even counties. Our immunity for the future depends a good deal upon the efficiency of the disinfectants which have been employed in those localities where the disease has occurred, and where, if the poison which is left by it has not been thoroughly destroyed, it will be almost certain to occur again. It appears to us that some risk arises here out of the insufficient distinction made in the popular estimate of them between true disinfectants and mere deodorizing antiseptics. The latter do, in effect, merely lock up the poison which they deal with; and the harmless condition to which, for the time, it is reduced by their agency, may be only a temporary result of their employment. Lapse of time may set it free again; and, plainly, it is only those agencies which decompose and break up the organic matters implicated, redistributing their elements in new forms of combination, that are unquestionably and ultimately trustworthy. For these reasons, we should greatly prefer, after a thorough washing of the infected premises with some alkaline ley, the use of sulphurous acid or chlorine gas—the one obtained by burning sulphur and the other by adding hydrochloric acid to the peroxide of manganese—in the cow-house where the plague has been, to the use of carbolic and other tar acids. And we believe that the agricultural public are greatly indebted to Dr. Voelcker, the chemist of the Royal Agricultural Society of England, and to Mr. Walter Crum, F.R.S., for that distinction urged by them between disinfectants and antiseptics, which does not appear to have received due attention in the recommendations of the Cattle Plague Commissioners.

Reference was made last quarter to the then impending attempt to collect statistics of our live stock. The returns have since been published, and we learn that on the 5th of March (when, however, neither the calving nor the lambing season was over) we had the following quantity of live stock in the country:—

	Enumerated, 1866.		
	Cattle.	Sheep.	Pigs.
England	3,307,034	15,124,541	2,066,299
Wales	541,401	1,668,663	191,604
Islands	17,700	57,685	22,887
Scotland	937,411	5,255,077	219,716
Ireland	3,493,414	3,688,742	1,299,893
Total	8,316,960	25,794,708	3,800,399

This amounts, as regards Great Britain, to about 10 cattle of all ages, 40 sheep, and 6 pigs, to every 100 acres of England; and to 5 cattle, 28 sheep, and 1 pig, to every hundred acres of Scotland, of which, of course, so much larger a proportion is waste and moorland. Another table in the Government returns on this subject indicates the corresponding live-stock population of other countries. Comparing it, however, not with the acreage, but with the human population of the several countries, the extent of their dairy husbandry is very strikingly illustrated by this table, which shows, that while there is only one cow for every nine persons in Great Britain and Ireland, there is one for every two in Denmark, one for every three in Holstein, one for every three-and-a-half in Sweden, Holland, Prussia and Saxony; one for every six in Austria, and one for every six-and-a-half in France. The universality of the cattle plague in Cheshire is shown in these returns by the number of cattle in that county, 93,844, as compared with 90,439, which is the number on those farms where the disease had appeared.

The meat supply of the country has received ample discussion during the past quarter at the hands of both local and central societies. The increase of fertility by both deeper tillage and more liberal manuring, the adoption of special rotations of crop, and, in particular, the cultivation of green crops in succession to one another; the use of potatoes, and of home-grown grain, as cattle food; the selection of fitting breeds and animals and their management during the growing and the feeding periods, which are now understood to be coincident from beginning to the end of each, was fully discussed by Mr. Robert Smith before the London Farmers' Club, and by Messrs. Hope, Wilson, and McCombie, before the Edinburgh Chamber of Agriculture. The special details of cultivation and field management necessary to a large production of food for live stock on the farm have been carefully described by Professor Wrightson, of the Royal Agricultural College, before the Cirencester Farmers' Club, and by Mr. Alderman Mechi, before the Wenlock Farmers' Club: and capital papers on the general management of live stock, and on that particular treatment of this department of farm management which the cattle plague has called forth, have been delivered before English, Scottish, and Irish Farmers' Clubs. The society which has probably done least for any serviceable mitigation of the calamity which has befallen us is the Royal Agricultural Society of England, whose council were, at the late general meeting of the society, taken vigorously to task by Mr. Arkell, a Wiltshire farmer, for the inaction they had displayed.

We must except from the charge of that usually deficient and imperfect discussion of agricultural subjects which they receive at the occasional meetings of the English Agricultural Society, one very instructive lecture recently delivered in its rooms by Dr. Voelcker, on the proper conditions of field-experiments. The following were the points to which he referred:—

1. Such experiments need not be on a large scale. One-twentieth part of an acre of root crop, one quarter of an acre of corn or grass, will answer fairly any simple question that is put to it by the application of a manure. A larger extent sometimes involves a fatal difference of treatment in the several parts of it, and unless the plots be small enough to be treated virtually *together*, the results will not be capable of comparison.

2. These experiments ought to be conducted on soil of what may be called an *indifferent* character — level, fairly drained, uniform as to depth, and without any marked character as to composition or texture. It should be neither stiff nor light; nor should it be too rich, for as the distinctive effect of different foods cannot appear in the case of a man already fully fed, so manures cannot produce their characteristic effect, or indeed any effect at all, on soil already full of all that plants require.

3. The result of the experiment depends on the time and mode in which it is conducted. As to time:—Experimental manurings on grass lands on which it is proposed to try the effect of slowly dissolving fertilizers should be done in autumn. Even ammoniacal salts may be applied in autumn, if on land possessing any retentive character. Nitrates, on the other hand, which the soil allows to

pass through it, must not be applied till spring. It is thus plain that a comparison of ammonia salts with nitrates sown together in autumn will give very different results from a similar comparison made in spring time. As to mode:—Care must be taken to ensure the uniform distribution of the fertilizers. Concentrated manures should be mixed with at least three times their bulk of some harmless diluent. The broadcast manure distributor should be employed to ensure their uniform application to grass or corn, or they may be sown by hand over the drilled fields for roots before the plough covers the dung in the drills by splitting the intervening ridgelets.

4. A careful record must be kept of the composition of the manures employed, of the character of the soil, and of its past agricultural history, in order that the result may be read in the light of the information thus preserved.

5. It is of the greatest importance that the experiment be devised so as to reply to a very simple question. If complicated mixtures of manures be used, the result cannot be attributed to its proper cause with any certainty. Let the experiment be devised so as to be sure that it shall answer "yes" or "no," as to the effect of a single ingredient.

6. The experiments, moreover, must have regard to the fitness of the soil and climate to the plant which is employed to test the manures by. It is as useless to try the effect of manures on Indian corn in Scotland as it would be to test them by means of mangel wurzel in Sweden. So also the soil should be fitted to the habits of the plant. The lupine fails on land with a hard, cold subsoil, not because the food it requires is not present, but because its deep taproot requires a subsoil in which it can extend.

7. In reading the results of experiments, regard must be had to the character of the season, wet or dry, early or late, cold or warm. And extreme diligence should be used in noting all the successive appearances of the crop under variations of weather throughout the year.

Lastly, the operator must not only have unbounded patience—waiting long and putting his question frequently before he satisfies himself that he has got the answer—but he must have both pluck and self-denial enough to throw his results into the waste-paper basket, rather than mislead his brother farmers by the publication of unsatisfactory conclusions.

On this same subject Professor Buckman has pointed out that careful observation by the farmer of the varying natural conditions under which the ordinary rules of farm practice are carried out, will often teach as much as can be learned from well-defined experiment, provided a careful record be kept of the field-results which are obtained under the varying circumstances of early or late farming, cold or warm, wet or dry air and soil, and even deep or shallow tillage and seed bed, all of which may have been imposed upon him by the character of the year.

The list of recently introduced agricultural plants, on which Mr. Buckman comments in the columns of the 'Agricultural Gazette,' includes the following:—Schroeder's Brome grass, a coarse species of a coarse genus, which is not likely, except under sewage irrigation and excessive consequent succulence of growth, to be of much service to English agriculture: *Anthyllis vulneraria*, or Lady's fingers, a common English wild plant, whose hairiness and dryness are said to be diminished or to disappear under cultivation, so that in certain circumstances it becomes a useful forage plant: *Symphytum asperrimum*, the prickly comfrey, yielding a large bulk of forage useful as cow-food, which, however, requires to be cut often while young, as it soon becomes too rough and unmanageable: and the cattle gourds or melons, which furnish in hot summers a great quantity of somewhat insipid and watery flesh, also good for cow-food.

Among other subjects less within the scope of this "Chronicle," to which the attention of agriculturists has been directed during the past quarter, are the need of central chambers of Agriculture, through which attention to class interests can be urged upon Government; the necessity of altered arrangements for the supply of animal food to consumers—an extension of the dead-meat market at the expense of the existing live-cattle markets, in London and in other large inland towns; and the existence of considerable dissatisfaction in many country districts with the rate of payment for farm-labour. No doubt this will gradually rise, and it is very desirable that it should. The rapid draught which is being made upon the number of the labouring class in rural districts by other better-paid occupations tends inevitably to this result. And the greater need of labouring men which exists in agriculture, with every extension of the meat manufacture now stimulated so much by market prices, acts in the same direction.

II. ASTRONOMY.

(Including the Proceedings of the Royal Astronomical Society.)

Mr. W. L. Dickinson has read a paper before the Literary and Philosophical Society of Manchester, containing the results of calculations relative to the Eclipse of the Sun, and to two Occultations of the star Aldebaran by the Moon, visible this year. The calculations have been made for the Observatory of Robert Worthington, Esq., F.R.A.S., Crumpsall, near Manchester, Lat. 53° 30′ 50″·0 N., Long. 0° 8′ 56″·16 W. The elements used in the computations have been obtained from the 'Nautical Almanack.' The partial eclipse of the sun, October 8, 1866, is partly visible at the Observatory, and

Begins	4h. 19m. 39s.	Mean time at Greenwich.
Greater phase . .	5h. 21m. 35s.	

At Crumpsall the Sun will set at 5h. 27m. Magnitude of the eclipse (Sun's diameter = 1). 0·480.

Angle, from North Pole, of first contact, 43° .	Towards the west for direct image.
Angle, from Vertex, of first contact, 76° .	

At the same meeting of this Society, Mr. Brothers, F.R.A.S., stated that, while observing the Moon with his five-inch achromatic telescope, at about eight o'clock on the evening of March 25, he observed a small dark body cross the disc diagonally, from left to right, a little below the spot Copernicus. The motion was very rapid, and similar to the passage of a luminous meteor across the field of view. He conceived it might be a meteoric body passing through space at a distance considerably beyond the limits of the earth's atmosphere.

Mr. Daubrée has given to the Academy of Sciences a continuation of his "Synthetical Researches relative to Meteorites." In this part he shows that the siliceous constituents of meteorites are, for the most part, basic silicates, differing from the silicates constituting the superficial crust of the earth, but closely resembling the eruptive rocks. He supposes the masses to have been formed originally at a very high temperature, but for several reasons believes that they have crystallized at a lower temperature than in his own experiments to reproduce them. He supposes also that the fragments which reach our earth have been detached from much larger masses, probably at a far distant period of time. But although long circulating in space, it is only when they reach our atmosphere that they suddenly become incandescent, by which their exterior becomes vitrified, while the interior remains unchanged. The interior, therefore, represents the state of the mass as it circulated in space. It is clear, however, that oxygen has played an important part in the formation of meteoric stones, and the author also thinks in the formation of all planetary bodies. This part of M. Daubrée's paper is very long, and we have only indicated the principal point. The memoir is a valuable contribution to chemical geology.

Proceedings of the Royal Astronomical Society.

By desire of the Rev. R. Main, Director of the Radcliffe Observatory, Oxford, Prof. F. Kaiser, Director of the Observatory at Leyden, has presented to the Royal Astronomical Society a brief account of his investigations of Airy's double-image micrometer. The Astronomer Royal himself has given a complete theory and description of this micrometer. From that theory and description it appears that, with the double-image micrometer, errors are to be feared arising from the following sources:—(1), Periodical errors of the micrometer screw; (2), Variability in the mutual distance of the threads of that screw; (3), Distortion of the images.

The periodical errors of the screw may be very different at small differences in the readings of the micrometer-head, and require therefore a particular inquiry. The errors arising from the sources (2) and (3) do not compensate themselves in brief periods, and their common amount may be determined by the same inquiry.

In the micrometer as made by Simms one half-lens is quite fixed, while only the other can be moved by the micrometer-screw. This construction makes it impossible to eliminate the periodical errors of the screw at the measurements themselves. If the fixed half-lens could only be moved so much as the amount of one revolution of the micrometer-screw, we could hereby (according to Bessel's theory) eliminate at each measurement the periodical errors of the screw, and this would be a great gain. If the fixed half-lens could be moved as much as the movable one, the measurements could be extended to angles twice as large as can now be measured with the micrometer. Then it would, however, be shown together, with relation to the fixed lenses. By this modification the price of the instrument would certainly be considerably raised, but it would be well worth the extra expense.

After a long and elaborate investigation of the various errors and methods of eliminating their influence on the final results, Prof. Kaiser arrives at the conclusion that the Astronomer Royal has, by the invention of his double-image micrometer, rendered an important service to astronomy. Indeed, he doubts whether, besides the heliometer, a second double-image micrometer exists by which measurements can be effected so accurately as by Airy's instrument. That instrument requires, however, a very rigorous and difficult inquiry, in order to give it the accuracy of which it is capable, and it demands also great prudence in the use of it.

A micrometer like Airy's can only render its services if it is adapted to a large and precious refractor. The price of the micrometer would, even if it were doubled, still remain very insignificant in comparison with that of the refractor. Therefore it would appear very desirable to give to the micrometer the more complicated construction above alluded to, even if its price were thereby considerably increased.

Rev. T. W. Webb has given a further notice of the great nebula in Orion. A comparison of the various representations of the great nebula in Orion, which have been given for a period of many years, seems to lead inevitably to the conclusion that our knowledge of its real aspect is still far from complete. While Mr. Huggins's most important discovery of its true constitution renders the idea of change more conceivable, it must be admitted that any alterations of form or brightness which may have been in progress since the employment of the telescope are so masked by discrepancies of declination as to preclude the possibility of drawing any fully satisfactory conclusion.

It would be superfluous to refer to the variations which are so well known to arise from diversity of weather, instruments, eyes, and pencils, and especially from the unwarrantable carelessness of engravers: it only remains to be considered whether these are the sole causes of the striking differences by which we are confronted, or whether, after making due allowance for all these sources of error, there may yet be a residuum of actual change. No other means of investigating this point seem so promising as the multiplication of designs by different observers, in different climates, and with different optical means. From such an accumulation of testimony we might hope to deduce a much closer approximation to the truth.

The sketch, of which a copy was shown to the meeting, was commenced in December, 1863, and continued with many interruptions till the present season.

In this attempt to show some part of what may be visible in a certain circumscribed portion of the nebulosity, with an achromatic of 5½ inches aperture and an eye of average capacity, the object has been to represent the general arrangement of the luminous haze; and the few stars contained in the sketch are inserted merely for the purpose of more convenient identification and reference.

The author stated that he had the less hesitation in bringing forward these particulars, as he had the pleasure of knowing that his observations on the "rift" and the "lake" or opening, had been in great measure confirmed by Mr. Knott with his beautiful 7⅓-inch object-glass; and it was therefore believed there would be little difficulty on the part of any adequately provided observer in verifying them.

A. S. Herschel, Esq., has given an interesting account of the Path of a Detonating Meteor. Shooting-stars, it is well known, are so abundantly observed on certain nights of the year, that already, at the end of the last century, the term *meteorode* was applied on this account to the night of the 10th of August. It is suspected that large meteors also make their appearance on fixed nights of the year, although not with the same frequency or regularity as the most constant star-showers.

On the 21st of November, 1865, at 6h. 5m., G. M. T., a meteor about three times as bright as Venus is at its brightest, and having an apparent diameter of 8′ or 10′, was observed by Mr. Warren De la Rue, near Cranford. The meteor rose from the eastern horizon, being surrounded at first, like a comet, by a parabola-shaped halo of light, reminding an observer of the zodiacal light in its form, but rapidly rising and becoming brighter. When at an altitude of about 40° due east, the meteor emerged like a fireball from a roman candle, of a blue colour, about a quarter of the apparent diameter of the full Moon in width, and drawing after it a trail of reddish-coloured sparks, $2\frac{1}{2}$° or 3° in length; as it passed overhead the outpouring and falling behind of the matter forming the train became distinctly visible. At Wimbledon, near London, where the meteor was seen by Mr. F. C. Penrose, it vanished suddenly, or at any rate very rapidly, about 8° N.W. of *α Lyræ*. It traversed the entire length of the valley of the Thames—a distance of seventy-five miles—from forty-one miles above the Nore to twenty-seven miles above the earth's surface in the neighbourhood of Henley-on-Thames. On the average of four separate accounts, estimated by different observers between four and ten seconds, the time taken by the meteor to travel the entire distance, about seventy-five miles, was six seconds and a half. On this estimate the velocity of the meteor relatively to the earth's surface was about eleven miles per second. The direction of the actual position of the meteor's flight was from a point in the neighbourhood of the constellation Taurus, between Taurus and the head of Cetus.

The distance of the meteor at the moment of its disappearance from Wimbledon, collectively determined from these accounts, is about thirty-six miles. At Wimbledon, Mr. F. C. Penrose heard a loud report, like that of a cannon fired off at the distance of some miles, distinct enough to be heard very plainly by one other person at Wimbledon, about two minutes and twenty seconds after the meteor disappeared. Sound, with its ordinary velocity of 1,090 feet per second in common air, would take two minutes and fifty-four seconds to travel the entire distance of thirty-six miles from the point of the disappearance of the meteor to Wimbledon. Considering, as before, the difficulty of fixing the exact position of the apparent path of the meteor, and hence the approximate nature of the real path concluded from the independent statements of the observers, the agreement of the calculated time with the time observed by Mr. Penrose, between the disappearance of the meteor and the occurrence of the sound, must be regarded as a near coincidence. There can be little doubt from this circumstance—from the nature of the sound, the great apparent brightness of the fire-ball, and from its near approach to the earth—that this meteor was really a detonating fire-ball.

Detonating meteors are described in the British Association Reports as having taken place in England during the last five years, very nearly on the same date of the year as the meteor of the 21st of November, 1865.

The epochs of the 9th–11th of February, and the 19th–21st of November are, therefore, dates deserving special attention, partly with a view of determining for the future the directions of the detonating meteors, and partly as showing, by their frequent return within very narrow limits of time about these dates, that aërolitic meteors, like the acknowledged star-showers of August and November, revolved in fixed orbits round the Sun.

In a note on the spectrum of the variable star α Orionis, W. Huggins, F.R.S., and W. A. Miller, M.D., LL.D., F.R.S., mentioned an important change which has been recently observed in the spectrum of this star. α Orionis is a variable star of great irregularity, both of period and of extent of change of brightness. These observers have recently found that the group of lines, and "shading as if of fine lines," terminated at its more refrangible end by the strong line No. 1069·5 in their diagram, is not at present visible in the spectrum of the star. The absence of this group is of great interest in connection with the variability of the star's light, especially as the time of disappearance of this group coincides with the epoch of the maximum brilliancy of the star.

Mr. Baxendell, whose successful prosecution of this branch of astronomy is so well known, mentioning this star, says:—"The variable α Orionis is irregular both in the extent of its variation and the duration of its period. I have often thought its light was at times variable in colour as well as intensity, being sometimes perceptibly more ruddy than at others."

The variation in colour, so well described by Mr. Baxendell, corresponds exactly to the change in colour of the star which would be produced by the absence or presence of the group of lines referred to above, since the position of this group in the spectrum is about the boundary of the "orange" towards the "yellow."

The Astronomer Royal read an important and interesting paper "On the supposed possible Effect of Friction in the Tides in influencing the Apparent Acceleration of the Moon's Mean Motion in Longitude," in reference to a communication to the Institute of France by M. Delaunay, in which he explains a portion of the apparent acceleration of the Moon as possibly due to a real retardation of the rotation of the earth, and conceives that such retardation may possibly arise from friction in the tidal movement of the waters. In suggesting this explanation, he lays down as fundamental theorems the two following:—First, that if the solid globe of the earth were covered with water, there would be high water under the Moon (considered as the only tide-producing body); secondly, that the effect of friction would be to make the semi-diurnal tides later than they would be if there were no friction.

Any treatment of the tides is, necessarily, very imperfectly applicable to the real motion of the waters, under all their complicated circumstances of unsymmetrical boundaries, varying depths, and unknown laws of friction. Still attempts have been made upon different hypotheses admitting of mathematical treatment, by which the different points of M. Delaunay's theory may be tested.

Newton, Laplace, and Airy agree in this, that there will be low water under the Moon. In a subsequent part of the 'Principia,' Newton thinks that the high water would in some measure follow the Moon's place.

Airy shows that the effect of friction is to accelerate the time of each individual tide.

It is a result of this friction that the velocity of the earth's rotation is not affected.

It is a further result of this friction, and the consequent disturbance of the form of the waters, that the Moon's motion is affected; her orbit is made to become large, and her motion in longitude is retarded. The phase of low water (and consequently of the tide) is accelerated by the friction. Amongst the conclusions arrived at in this elaborate memoir are the following:—The friction of the tides does not tend at any instant either to accelerate or to retard the rotation of the solid globe. The friction of the tides produces a retardation of the Moon's mean longitude.

It would seem probable that the reaction of these forces will in some way produce a retarding effect on the earth's rotation. There are other instances in the lunar theory in which the Moon's action on the equatorial protuberance of the earth is accompanied by action of that protuberance on the Moon, both producing well-recognized effects. But in a case like this before us, where the very existence of the force depends on friction, and consequent disturbance of the law of *vis viva*, the author does not profess himself able to follow out all the consequences. It will probably be difficult to say what is the effect of friction in more complicated cases. Conceive, for instance (as a specimen of a large class), a tide-mill for grinding corn. The water which has been allowed to rise with the rising tide is not allowed to fall with the falling tide, but, after a time, is allowed to fall, thereby doing work and producing heat in the meal formed by grinding the corn. It is not doubted that this heat is the representative of *vis viva*, lost somewhere, but whether it is lost in the rotation of the earth, or in the revolution of the Moon, Prof. Airy is quite unable to say.

In an addendum, dated April 5, the Astronomer Royal says he has at length discovered two terms which appear to exercise a real effect on the rotation of the earth. By a process of mathematical reasoning, he proves that there is a constant acceleration of the waters as following the Moon's apparent diurnal course. As this is opposite to the direction of the earth's rotation, it follows that from the action of the Moon there is a constant retarding force on the rotation of the water, and therefore (by virtue of the friction between them) a constant retarding force on the rotation of the earth's nucleus.

The author concludes by saying:—"I am very happy to give my entire assent to the general views of M. Delaunay on the existence of one real cause for the retardation of the earth's rotation."

C. G. Talmage, Esq., gives an account of a probable observation of Biela's comet. He states that while sweeping for Biela's comet, on the 4th of November last, he came upon a nebulous object which is thought very likely to have been the comet. From brief opportunities afforded to Mr. Barber and Mr. Hind, it is very probable that Mr. Talmage's object was really nucleus *L* of this comet. Unfortunately the weather was too unfavourable to allow of subsequent observations.

Mr. Huggins, F.R.S., has contributed an interesting paper on "The Bright Granules of the Solar Surface," to which we shall refer in our next number.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

Russia.—The 'Bulletin of the Imperial Society of Naturalists at Moscow,' vol. xxxviii., No. 3, 1865, contains fourteen short botanical papers, morphological, anatomical, and physiological, by Paul Reinsch, with two plates of microscopic drawings delineated from nature, which are very valuable contributions to science. As the plants which have furnished the illustrations are familiar and easily obtained, the observations of M. Reinsch may be readily verified. Four of these papers are devoted to the subject of vegetable cyclosis, or the motion of the protoplasmic currents in the individual cell. The plants and the parts in which M. Reinsch has observed cyclosis, and which have furnished the beautiful illustrations of the first plate, are—1. The cilia on the leaves of *Sempervivum tectorum;* 2. The youngest developing cells in the whorls of *Nitella syncarpa;* 3. The individual cells of the root and parenchyma of *Hydrocharis morsus rana;* 4. The cells of *Closterium lunula.* M. Reinsch describes three kinds of cyclosis, *viz.* the rotatory movement which is confined to one portion of the cell; the circulatory movement, where the proto-plasmic current sweeps around the entire circumference of the cell; and the rotato-circulatory, which is a combination of the two preceding movements. The rate of motion in the cells, or parts of cells, is variable, being accelerated and retarded by a rise or a fall of temperature. The quantity of protoplasm in the current is also variable. The remainder of these papers consist of interesting articles "On the reproduction of Bryum by axillary buds;" "On the Infusoria in the cells of Sphagnum;" "The development of the Stellate cell in the pith of the Cyperaceæ;" "Acrosyncarpia in *Bryum cæspiticum*," being an abnormal development of the sporangium; "The antheridia of *Nitella syncarpa*;" "The reproduction of *Tetraspora lubrica*," of a new species of *Staurastrum*, and also of those familiar Desmids, *Euastrum margaritiferum*, Ehren., and *Cosmarium cylindricum*, Ralfs.; and, lastly, a paper on the development of the spores of *Scapania nemorosa*, Nees.

France.—*The Influence of Light on Plants.*—The Parisian Academy of Sciences have received a highly interesting communication from M. Duchartre on certain well-known plants, which, too weak to support themselves, tend to twine around the nearest objects. They generally do this from left to right, that is, inversely to the motion of the sun, but some species turn in the contrary direction, and it is impossible to make either the one or the other change its direction. Palm, Von Mohl, Dutrochet, and latterly Darwin, have successively expressed the opinion that light was the cause of this tendency; but further experiments being wanting to confirm this theory, M. Duchartre, who had discovered that the Chinese yam could live a long while in the dark, resolved to try the effect of absence of light upon it. At the end of May last he placed one in a pot, and as soon as it showed its stem above ground he took it down to a cellar, where it remained in complete darkness until the 2nd of August following. The stem, in the course of seven weeks, grew to the length of a metre and a half. It looked withered and whitish, but was upon the whole strong and even stiff and perfectly straight, showing nowhere a tendency to twine itself round the stick which had been placed there for its support. Another yam was planted nearly a month later, and left exposed to daylight until it had twined itself twice round its stick. It was then taken and placed in the cellar, where its stem, still obeying its natural tendency, went round once more, but in a more vertical direction than before; after which it grew straight up along its pole, to which it was fastened as it grew. It was now again taken up into the garden, where it immediately began to twine round again, making five close turns; and when it was once more taken down into the cellar it continued its growth again in a straight line, and so on, according as it was alternately in the light or in the dark. The same phenomenon was observed, not only in the yam or *Dioscorea Batatas*, but also in the *Mandevillea suaveolens*; but, on the other hand, the bean and the *Ipomæa purpurea* continue to twine round their supports in the dark.*

In the 'Bibliothèque Universelle' of the 25th of March, 1866, there is a "Note on some new facts in Botanical Geography" by Edmond Boissier, from which we learn that there are certain

* 'Galignani's Messenger.'

plants whose congeners inhabit very distant regions, which have recently been discovered in Europe and Asia Minor, and which may be truly regarded as disjointed species. The first is the *Dioscorea Pyrenaica*, Bub., found by M. Bubani, an Italian botanist, on the Pyrenees. The genus Dioscorea is very numerous in the tropics, only a few species having been found in the temperate zones—for example, the *Dioscorea villosa*, L., in the United States, and the *Dioscorea Batatas* in Japan. No European species was known until this one was found in the Pyrenees by M. Bubani.

Another curious fact is the discovery by M. Kotschy of a Pelargonium in the Taurus mountains in Cilicia, the same plant having been subsequently found along the whole chain from Pamphylia to Armenia. The Pelargoniums, which include the so-called Geraniums of our conservatories, were supposed to be exclusively indigenous to the Southern hemisphere, most of the species inhabiting the Cape of Good Hope, and a few Australia.

The third case mentioned by M. Boissier is that of a Pilostyles, a parasitic plant which grows in great abundance upon the branches of a leguminous plant, described as an Adesmia, and which Bolero collected in Chili. This plant has no root, stem, or leaves, its flower is campanulate, about two lines in diameter, and sessile upon the bark of the Adesmia, the epidermis of which it tears during its development. It belongs to the family Rhizantheæ, and is, in fact, a miniature representative of the gigantic Rafflesia Arnoldii of Sumatra. Another species of the same genus was discovered by the naturalist Pohl growing upon the branches of a Bauhinia in the forests of Brazil. M. Boissier, in examining a fascicle of dried plants brought by M. Haussknecht from the mountains of the east of Asia Minor, found the branches of a spiny Astragalus covered with a Pilostyles, which on examination he determined to be a new species. M. Boissier calls it the *Pilostyles Haussknechtii*, and it completes a genus hitherto known only from South America, and of which, singularly enough, all the species are parasitic on leguminous shrubs. The Pilostyles is a diœcious plant, and so far only the male plant has been found, the female flower remaining still to be discovered.

It would be easy to enlarge this list of disjointed species—that is, of species growing isolated in botanical regions far distant from the rest of their family or genus. Take, for instance, the well-known fact that there is in the floras of Southern Europe only a single myrtle and a single laurel, whilst numerous genera and species of these shrubs inhabit the tropical and sub-tropical countries of both continents. "If, however," as M. Boissier suggests, "we consider that, in the Tertiary period, the myrtles and laurels were diffused in Central Europe, we get a glimpse of an explanation, being led to assume—as has been so well shown by

M. Alphonse De Candolle in his 'Géographie Botanique'—that species are of different antiquities, and to hope that as our knowledge of the floras of preceding geological epochs becomes more complete, it will by degrees make us better understand the present distribution of plants."

It appears that M. Reveil, recently deceased, sent for competition to the French Academy an essay "On the Action of Poisons on Plants." According to his observations, not only mineral but organic acids, as citric and tartaric acids, in dilute solution, will cause the death of the plant which absorbs them. It is the same with several saline solutions and mixtures much diluted with alcohol and ether, which may be absorbed with impunity by animals. The committee to whom this paper was submitted, have marked their appreciation by the award of an honourable mention.

SCOTLAND.—*Vegetable Nosology.*—This important but little understood part of Botany is attracting some attention. At the meeting of the Botanical Society of Edinburgh, Dr. Lauder Lindsay read a paper "On the Diseases of Plants in connection with Epidemics in Man and Animals." The 'Lancet' of the 14th of April also contains an abstract of Dr. Salisbury's views and experiments on the Cryptogamic origin of disease. The fungoid origin of disease is no new opinion. Eight years ago, the late Dr. Mitchell, of Philadelphia, published a pamphlet on this subject, which was very favourably received. The prevalence of certain diseases amongst plants, produced by microscopic fungi, and at the same time of certain infectious diseases amongst animals, was known even in the middle ages. The course which investigation has recently taken on this subject will doubtless lead to discoveries of great value.

At the same meeting Dr. McNab contributed a paper "On the Development of Leaves." He reduces them in all their varieties of form to seven types—1. Basifugal, or leaves with the leaflets developing first at the base; 2. Basipetal, the leaflets developing first at the apex; 3. The Cyclical type—leaflets developing in a circle, ex. Lupinus; 4. The Divergent type—the central leaflets developing first, and those of the apex and base last; 5. The Simultaneous type—all the leaflets developing together; 6. The Ternate type—ex. Thalictrum, Aquilegia, &c.; 7. The Parallel type. Dr. McNab thinks that both simple and compound leaves belong to these types, the difference being merely one of degree of development and not of type.

We append to these views of Dr. McNab the following synoptical table of the types of nervation of leaves taken from the 'Physiotypia Plantarum Austriacanum' of Professors Ettinghausen and Pokorny, a work recently published by the Austrian Government, as likely to prove interesting to English botanists.

I.—*Forms of Nervation, with a single Primary Nerve.*

1. Nervatio Camptodroma. Bowed or inflected nervation. *a.* Dictyodroma—netted; ex. Willow. *b.* Brochidodroma—looped; ex. Circæa. *c.* Veræ—True; ex. Rhamnus.
2. Nervatio Craspedodroma. Marginate nervation. *a.* Simplices—simple; ex. Fagus, Castanea. *b.* Compositæ—compound; ex. Polemonium cæruleum.
3. Nervatio Hyphodroma. Concealed nervation; ex. Coniferæ.

II.—*Forms of Nervation, with several Primary Nerves.*

4. Nervatio Parallelodroma. Parallel nervation; ex. Grasses.
5. Nervatio Campylodroma. Curved nervation; ex. Musaceæ.
6. Nervatio Acrodroma. Convergent nervation. *a.* Perfecta; ex. Convallaria. *b.* Imperfecta; ex. Arnica.
7. Nervatio Actinidroma. Radiated nervation. *a.* Reteformis—netted; ex. Nepeta. *b.* Imperfecta—imperfect; ex. Urticæ. *c.* Marginales—marginated; ex. Acer.

March 8.—The Botanical Society of Edinburgh were presented by Dr. Carrington with specimens of *Scapania Bartlingii*, Nees, a species of Hepaticæ new to Britain. May 10.—Captain M. Norman, R.N., Madeira, read before this Society a paper "On the Effect produced on the Operator by the Poisoning of Plants in a Herbarium." In consequence of using an alcoholic solution of camphor and corrosive sublimate in poisoning his Madeira plants, Captain Norman had suffered twice from severe salivation. It appears that the plants were kept in a room much frequented by him, and being thus under the influence of a mercurialized atmosphere, he had suffered in the way he described. In the conversation which ensued after the reading of this paper, it was stated that none of the operators, engaged in poisoning plants for the herbarium of the University of Edinburgh, had experienced any inconvenience. Mr. Gilbert Stuart said that he had slept six months in a room where poisoned plants were kept, and had not felt any bad consequences. The only inference that could be deduced from these facts was that Captain Norman, and probably others *similarly* organized, are peculiarly susceptible to the effects of mercury.

America.—The manufacture of white paper from wood is now quite a success at the Manayunk wood-pulp works, Pennsylvania, N. America. The wood used is that of the *Liriodendron tulipifera*, L., or Tulip poplar, and the *Abies Canadensis*, Michx, or Hemlock spruce. It is brought to the works as ordinary cord wood, and is cut into chips by means of two immense machines, having cutters attached to rotatory discs, capable of cutting from thirty to forty cords of wood in twenty-four hours. These chips are conveyed in wagons to the boiling-house, and placed in boilers, where the reduction to pulp is effected. The pulp thus reduced is then conveyed to pulp-engines, is worked in these engines, and run through cleaning machines. From the cleaning machines the pulp is taken to the bleaching-house. After having been bleached, it is then ready to be made into paper—in the same way as any other pulp. Excellent white printing paper very good for newspapers, and at a price of three cents per pound less than is charged for the same quality of paper made from rags, is manufactured from this pulp by Martin Nixon, at the Flat-rock paper-mills, adjacent to the pulp works. The wood-pulp must, however, be mixed with about twenty per cent. of straw-pulp, this mixture improving the quality of the paper. These works have been so successful, that the price of paper for newspapers has declined three cents per pound since they have been in operation. This is a very great step in the progress of those arts which contribute so greatly to our comfort and civilization.

England.—At the meeting of the Royal Horticultural Society, held on the 1st of May, at South Kensington, Mr. W. G. Smith exhibited a fine specimen of *Morchella crassipes*, Kromb., a species entirely new to Britain. This plant is admirably figured by Klotzsch in Krombholz's magnificent work on 'Fungi.' It was found in red soil by Miss L. E. Lott, at King's Kerswell, near Newton Abbot, Devonshire, at the end of April last.

Obituary Notice.—English science has sustained a severe loss in the death of Dr. W. Harvey, F.R.S. and L.S., Professor of Botany in Trinity College, Dublin, and well-known by his valuable works on 'Algæ,' and on the 'Botany of South Africa.' Dr. Harvey died on the 15th of May, of phthisis, at Torquay, whither he had repaired for the benefit of his health.

IV. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

But few additions of general and popular interest have been made to the knowledge of chemical science since our last publication. M. Baudrimont has made some curious experiments illustrating the Allotropism of oxygen. It is well known that when hydrochloric acid reacts on binoxide of barium, binoxide of hydrogen is produced, while by the action of the same acid on binoxide of manganese chlorine is set free. It seems clear, then, that chlorine has more affinity for barium than for the oxygen that peroxidizes the barium; while the contrary is the case with the manganese and the oxygen which peroxidizes it. This may be demonstrated by filling a bottle with chlorine and introducing some finely-powdered binoxide of barium mixed with a little water. An active effervescence ensues, and after a time the chlorine will be found to have disappeared, its place being taken by oxygen, which, however, will not affect ozone paper. Another difference between the two metallic peroxides is also mentioned. Sulphovinic acid when heated with binoxide of manganese yields aldehyde; but when heated with binoxide of barium it yields oxygen, olefiant gas, ether, and sulphurous acid. Binoxide of hydrogen prepared from binoxide of barium is decomposed by binoxide of manganese. M. Baudrimont states that he has succeeded in preparing binoxide of hydrogen from binoxide of manganese, which is decomposed by binoxide of barium. And further, the two oxygenated waters from these different sources when brought together mutually destroy each other. The author also states that when oxygenated water is submitted to the action of the battery, equal volumes of hydrogen and oxygen are obtained, showing that the binoxide of hydrogen is decomposed in preference to the water. M. Baudrimont speculates reasonably enough that all bodies may exist in two allotropic modifications. Hydrogen, for example, giving, as we have seen, two distinct binoxides, it is probable that it is present in distinct and complementary states in those oxides.

Some new compounds of sulphur and carbon have been obtained by O. Loew. Sesquisulphide of carbon is an amorphous brown body, which decomposes into its constituents when heated to 210° C., indicating a loose state of combination of the elements. A hydro-sesquisulphide of carbon is also a brown amorphous body, having a faint odour of garlic. When this body is boiled with alkalies it gives oxalic acid and lower sulphides of carbon. By acting on a chlorine compound of hydro-sesquisulphide of carbon dissolved in bisulphide of carbon, with a solution of bromine in bisulphide, the author obtained a body which appeared to be monosulphide of carbon, but found it impossible to procure the compound perfectly pure.

Among the novelties in organic chemistry, we may first allude to the discovery by Drs. Bence Jones and Dupré of a substance resembling quinine in all the tissues of the body—resembling quinine, that is, in being precipitable by the same reagents, and in being possessed of the property of fluorescence. About the chemical composition of the substance nothing is as yet known or has been made public. The substance is obtained by first treating the animal matter with a dilute acid, then neutralizing the acid solution with an alkali, and subsequently extracting the fluorescent substance with ether. Not having as yet obtained the substance in a crystalline form, the discoverers have provisionally named it Animal Quinoidine. It deserves to be mentioned that the experiments undertaken in the course of this research showed the extreme delicacy of the fluorescence test for quinine itself. The author found that a grain of quinine dissolved in one million eight hundred parts of water showed the blue fluorescence distinctly in twenty grains of the solution. For further information on this very interesting matter, we may refer the reader to Dr. Jones's lecture.*

M. Berthelot's continued researches on Acetylene have led him to the important discovery that at high temperatures various hydrocarbons will combine with each other, and with hydrogen to form higher carbides of hydrogen; and have also suggested to him a new theory of the origin of petroleum. Daubrée has speculated that the alkaline metals may exist in the free state in the centre of the earth. Carbonic acid, M. Berthelot states, is everywhere infiltrated in the crust of the earth, and may come in contact with the alkaline metals at very high temperatures. In this way acetylides would be formed. The same acetylides, he states, would also be formed by the contact of alkaline metals with earthy carbonates below even a dull red heat. By the action of steam the alkaline acetylides so produced would set free acetylene, and this body being unable to exist under the conditions in which it must be placed, we obtain instead the products of its condensation, bodies allied to petroleum and bitumen.† This view of the formation of the natural carbides of hydrogen, by purely mineral reactions, will no doubt attract much attention from chemical geologists.

While speaking of the carbides of hydrogen, we must not omit to mention the discovery by Mr. Schorlemmer of a new series in that still unexhausted mine of discovery, coal-tar. These bodies are still under investigation, and we shall probably have to refer to them on another occasion.

In analytical and technical chemistry we have observed nothing that requires a notice.

In chemical literature a few useful books have appeared. Mr. H. Spencer, B.A., has published a very useful book, 'Elements of Qualitative Chemical Analysis,' which is unfortunately disfigured by a large number of errata, not all of which are corrected in the long table at the beginning of the work. This is a great fault in a book intended for beginners, who will seldom take the trouble to make the corrections before they commence to use the book. One very useful feature in the work is the explanation of all the reactions by equations. It need only be added, that the symbols and equations are expressed in the new system of notation, which alone will give the work a value in the estimation of many.

* 'Chemical News,' April 27, 1866.

† 'Comptes Rendus,' lxii., p. 949.

A new edition of Bowman's 'Practical Chemistry,' edited by Mr. Bloxam, has been issued. In this edition the editor has omitted the symbols and equations; but at the same time he has contributed considerably to the practical value of the work by re-arranging and adding to the analytical part.

A 'Report of the Proceedings of the Chemical Department of the Highland and Agricultural Society of Scotland,' made by the chemist to the Society, Dr. Anderson, deserves the attention of agricultural chemists. In it Dr. Anderson shows, in opposition to Liebig, that the manurial value of uric acid is quite equal to that of the other nitrogenized ingredients of Peruvian guano. There is also a very useful paper "On the Growth of the Bean Plant," and another "On the Adulteration of Oil-cake."

Proceedings of the Chemical Society.

On March 1, Professor Church made a communication "On New and Rare Cornish Minerals;" and Mr. J. A. R. Newlands read a paper, entitled "The Law of Octaves, and the Causes of Numerical Relations among the Atomic Weights."

Professor Wanklyn described "A New Method of Forming Organo-metallic Bodies." A paper, by Mr. C. Wright, "On the Action of Sunlight upon Sensitive Photographic Papers," was also read. The author has made an extensive series of experiments in order to determine the relative sensitiveness of paper prepared with different reagents. His practical results are given in the following table:—

Paper prepared with	Chloride of Silver	1·000
,,	Chloriodide of Silver	1·078
,,	Chlorobromide of Silver	4·022
,,	Bromide of Silver	2·396
,,	Bromiodide of Silver	4·060

On March 25, Dr. Hugo Müller read a paper "On Hydrocyan-Rosaniline." When aqueous solutions of a salt of rosaniline and of cyanide of potassium are mixed, the red colour of the rosaniline salt is destroyed, and a white precipitate of the compound above-named is formed. The production of this compound affords, the author believes, the means of determining the commercial value of samples of rosaniline, the crystallization of which, he has found, to be no proof of purity.

At the same meeting, Dr. Frankland gave an account of "Metropolis Waters during the years 1865–66," founded upon the results of his monthly analyses. This, with a very useful account of the analytical methods adopted, will be found in the 'Journal of the Chemical Society,' for June, 1866.

At the next meeting, on April 5, Mr. J. Spiller read a paper

"On the Estimation of Phosphorus in Iron and Steel." The process usually adopted by analysts is that of Fresenius, which the author finds may be considerably curtailed without impairing the accuracy of the results. Following Fresenius as far as the partial reduction of the ferric solution by sulphurous acid, Mr. Spiller dispenses with the next step—precipitating the phosphoric acid with the remaining ferric oxide by boiling with acetate of ammonia—and adds sesquicarbonate of ammonia to the partially reduced solution until the precipitate, at first red, becomes greenish, showing the precipitation of some ferrous oxide. The temperature of the solution must not exceed 70° or 75° Fah. while this part of the operation is conducted. The precipitate being collected, is next dissolved in hydrochloric acid, and to the warm solution is added in succession citric acid, ammonia in excess, and sulphide of ammonium. By this means the whole of the iron is precipitated, and may be separated by filtration. The filtrate being slowly evaporated with full exposure to air, and the sulphur deposited removed, the phosphoric acid may be precipitated in the usual way.

Professor Wanklyn afterwards read a paper "On Magnesium," showing the ordinary magnesium ribbon of commerce to be remarkably pure, and pointing out the resistance offered by this metal to the action of chlorine, bromine, and iodine. The author also showed that magnesium-amalgam decomposes water with greater facility than sodium amalgam.

Mr. E. T. Chapman then made some observations "On Mercury-Ethyl," and Mr. W. A. Tilden read a paper, entitled "Further Contributions to the History of the Periodides of Organic Bases."

Mr. M'Leod afterwards exhibited an experiment, showing, on a large scale, the formation of acetylene by the incomplete combustion of marsh gas.* Mr. M'Leod employed the form of apparatus used by Dr. Hofmann to show the combustion of oxygen in hydrogen, ammonia, or coal gas, in the present experiment burning the oxygen (atmospheric air may be employed) in an atmosphere of marsh gas,† and causing the products of combustion to pass into an ammoniacal solution of cuprous chloride. Mr. M'Leod then showed the explosive properties of the characteristic red precipitate produced by acetylene in the copper solution, and hitherto called acetylide of copper, but the exact composition of which has not yet been made known. The author believes it to contain cuprous oxide in combination with the acetylide.

Dr. Hofmann subsequently made some observations "On the Synthesis of Guanidine."

* 'Journal of Science' for April, p. 266.

† The apparatus will be found described in the 'Journal of the Chemical Society' for May, 1866.

On April 19, Professor G. C. Foster delivered a lecture "On the Thermal Phenomena accompanying Chemical Action;" and papers "On Picric and Oxypicric Ethers" were communicated by Drs. Stenhouse and H. Müller.

On May 3, Dr. J. H. Gladstone read some notes "On Pyro-phosphodiamic Acid;" and Mr. R. Warington, junior, gave an account of his "Researches on the Phosphates of Calcium, and upon the Solubility of Tricalcic Phosphate." The latter showed that the solubility of the Tricalcic Phosphate was much greater in water containing chloride of ammonium, or saturated with carbonic acid, than in pure water.

At the meeting on May 17, several papers were read, of which we can only give the titles:—"On the Production of Acetic and Propionic Acids from Amylic Alcohol," by Mr. E. T. Chapman; "On the Oxidation of Ethylamine," by Professor Wanklyn and Mr. E. T. Chapman; "On the Action of Acids on Napthylamine," by Mr. Chapman. On the same evening Sir Robert Kane gave an account of "Some Derivatives of Acetone," and the Rev. T. Gibsone gave the outline of a criticism of "Dalton's and Gay Lussac's Formulæ for the Calculation of Vapour Densities." Afterwards a paper, by Mr. Hadow, "On the Nitro-prussides, their Composition and Manufacture," was read. The mode of manufacture proposed by the author is complicated, but its success was proved by a large and beautiful specimen of crystallized nitro-prusside of sodium exhibited at a previous meeting. For the production of this body the author first passes nitrous acid, formed by the action of nitric acid on starch, into a solution of caustic soda. A calculated quantity of this solution of nitrite of soda is then added to a mixture of acetic acid, ferridcyanide of potassium, and corrosive sublimate. A rather complicated reaction ensues, and the solution will contain nitro-prusside of sodium, cyanide of mercury, acetate and chloride of potassium, which may be separated by crystallization.

V. ENTOMOLOGY.

(Including the Proceedings of the Entomological Society.)

The devastation of a species of white ant in St. Helena was the subject of a communication from Mr. E. L. Layard, made to the Entomological Society at its meeting in May. Introduced in timber from the west coast of Africa, about twenty years ago, it had latterly become so destructive as to threaten the ruin of James Town. Everything made of wood was destroyed; the books of the public library had been devoured, the theological works being especially preferred, because, it is supposed, less used, and the insects, therefore, less disturbed in them than in the others. Partially Kyanized wood had been found ineffectual to prevent their eating through to the untainted part beyond; and tin-plate, owing to the corrosion of the metal from the probably acid secretion of the animals, afforded no permanent protection. So far the ravages had been confined to the town.

At a recent meeting of the Oxford Microscopical Society, Mr. Robertson exhibited some *Acari* obtained from the chest and abdomen of a common fowl, which had been killed for the purpose of dissection. They presented the appearance of small white specks on the peritoneum, and in the chest around the bifurcation of the trachea; they were also dotted over the surface of the lungs. All the *acari* had four pairs of legs.

We have lately received a work on Italian Entomology, published at Padua. It is entitled 'Entomologia Vicentina,' and comprises a list of insects of all orders found in the province of Vicenza, with descriptions of the commoner species. It is by the "Abate Francesco Disconzi," and forms a royal octavo volume of 318 pages and 18 plates. Such a work from the Italian press deserves to be recorded in the "Chronicles."

The Royal Society of Sciences of Liege has just issued the first part of Dr. Chapuis' monograph of the *Scolytidæ*, with excellent outline figures representing all the species. These are the insects—one of which is our well-known *Scolytus destructor*—which are popularly supposed to do so much injury to trees. There is little doubt, however, that they attack *exclusively* trees in a state of decay, and that therefore, as has been well observed by Mr. Wallace, they are to be regarded rather as benefactors, "teaching us, by their presence, that there is something wrong" than as enemies.

To those in want of a good and *reliable* work on our native Coleoptera, we would recommend Mr. Rye's 'British Beetles,' just published, with sixteen coloured plates—the best as to the drawing and engraving this country can produce; it is at ten-and-sixpence, a marvel of cheapness. If "not, in the common sense of the term, a popular book, it is, in fact, something much better," and it has the advantage over many popular books, of being written by one who understands his subject.

Entomological Society.

March.—At this meeting two Japanese collections of insects were exhibited, one by Mr. Stevens from Hakodadi, the other by M. Tegetmeier from Nagasaki, formed by a native. These and other collections clearly prove that Japan, like Northern Asia generally, derives the insect portion of its fauna from Europe, Several nests of the *Vespa sylvestris* were exhibited by Mr. F. Smith; many of these were interesting from their abnormal forms, the workers having been deprived of their queens. A large and important collection of insects was also exhibited by the Rev. O. P. Cambridge, made by himself in the Holy Land. This, it was understood, would form a portion of the materials to be used by the Rev. H. B. Tristram in his forthcoming work on the natural history of that country. In reference to a twig of a mulberry-tree sent from Saugor by Captain Alexander, on which were deposited a multitude of eggs of a species of *Ascalaphus*, Mr. McLachlan remarked on the statement made by Geoffroy that the *Myrmeleon formicarius* laid eggs which never produced anything; that these so-called eggs were the meconium, which, instead of being voided in a liquid shape, here took the form of egg-like bodies. A paper was read by Mr. Edward Saunders, entitled "A Catalogue of the *Buprestidæ* collected in Siam, by the late M. Mouhot." It comprised three new genera and thirty-three new species.

April.—A very curious arrangement of the eggs of a species of *Chrysopa* (?) from Australia was brought under the notice of this meeting by Mr. W. Wilson Saunders; they were arranged in a line on the bark of a tree, each egg supported on a stalk, the first, third, fifth, and so on, placed longitudinally and at right angles with the bark, while the intervening numbers were placed transversely at an angle of about 45°. Mr. Rogers sent for exhibition several individuals of *Pimpla oculatoria*, which he had bred from the egg-bag of a spider, on which it was parasitic. Mr. J. Jenner Weir exhibited some larvæ of the common meal-worm (*Tenebrio molitor*), which had done great damage in an extensive cellar by eating through the corks of bottles containing port wine, and thus allowing it to escape; they had also attacked the corks of the sherry bottles, but had invariably stopped short of eating through them. It was supposed that these larvæ had been introduced in the bran which had been used for packing the bottles. Mr. W. W. Saunders remarked that a quantity of manufactured corks in one of the London Docks had been destroyed by the larvæ of *Dermestes lardarius*, which were brought into the docks in a cargo of skins infested by these insects. Mr. F. Smith exhibited a specimen of *Bembex olivacea*, taken near Gloucester; the insect was figured as British by Donovan, but its claims as a British species have long been doubted.

May.—Mr. W. Wilson Saunders exhibited a very remarkable nest—supposed to be a spider's—from New South Wales, formed by bending a stout lanceolate leaf at certain definite angles into four portions, which, being cemented in some way at the edges, presented the figure of a nearly perfect cone; the base of the leaf constituted the floor, one side being left uncemented, evidently for entry and exit, and as this was underneath and skilfully protected by the side immediately above it, the whole must have been quite impervious to rain. Mr. Stainton exhibited a number of highly-finished drawings of the larvæ of various species of *Micro-lepidoptera*, collected at Cannes, and of their mining operations in the parenchyma of the leaves of the plants affected by them. Mr. Newman sent for exhibition some dead larvæ of *Hepialus lupulinus*. The interior of their bodies had been occupied by some species of fungus, which had sent out their mycelia in all directions through the skin. Mr. Janson exhibited *Throscus elateroides*, taken at Rochester, and new to Britain. Mr. E. L. Layard called the attention of the meeting to the devastation of the white ants at St. Helena. The Rev. Douglas Timmins contributed a paper entitled "Notes on the Insects of Hyères."

VI. GEOGRAPHY.

(*Including Proceedings of the Royal Geographical Society.*)

The newest discovery in geography must necessarily be that fresh distribution of land which has taken place since our last report. We are now speaking of physical distributions, for the political changes of Europe cannot well be chronicled in a scientific record until they are so well known to the world in general that they have lost all interest, whereas the works of nature, partaking, to some degree, indeed, of the capriciousness of human proceedings, still have a stability in themselves, or, at all events, excite so little hostility, that they may be set down at once as soon as they have taken place, without awaiting for the subsidence of the effervescence of their first appearance. The new distribution of land to which we refer, then, is not a partition of already existing territory among rival States, new boundaries to Denmark, Prussia, Austria, Italy, France, which will make antiquated the newest maps of Europe we have in our libraries, and will cause infinite perplexity to those who have to instruct the ingenuous youth from manuals, the result of careful filtering of standard works of some years back; but the actual redistribution of land and water in the Mediterranean by the appearance of a new volcanic island in the Bay of Santorin, an island in the Archipelago, about half-way between Europe and Asia, and a little way to the north of Crete. Thus this eruption, unlike political ones, is confined to the extreme south-eastern portion of the kingdom of Greece; but it resembles its prototypes to which we have referred in threatening destruction to the old whilst it promises that which is new.

The exploration of Palestine has proceeded with excellent success—maps have been corrected and improved, positions of many sites determined astronomically, a great number of important photographs prepared, two or three localities excavated, and steps taken towards the identification of some disputed sites. At the same time that much steady progress has been made, no startling discoveries have rewarded the labourers, and though the importance of all their discoveries cannot as yet be justly determined, nothing has yet transpired that would lead us to suppose that anything very new or very important has been brought to light. For some time past a series of papers have appeared in the 'Reader,' being translations of a "Note on the Formation of the Basin of the Dead Sea, and on the Changes which have taken place in the Level of the Lake," by M. Louis Lartet, a subject that belongs more properly to geology than geography, but which is important enough from both points of view to merit attention. Notwithstanding the tragical fate of Baron von der Decken, African exploration still continues to afford excitement to many travellers of various tastes and temperaments. The German Rüppel is on a journey to Abyssinia, in which undertaking he is assisted by a grant from the Senate of Frankfort. The fate of Englishmen, the survivors of the wreck of the St. Abbs Indiaman, supposed to be in captivity among the Somāli, has caused much excitement. Besides the means for their recognition mentioned below, the Rev. Mr. Rebmann, a missionary stationed at Rabbai Mpia, near Mombaz, has made several journeys into the interior, and meditates, if he can obtain further support, a more extensive search. Herr Gerhard Rohlfs intends to penetrate, if possible, to Wadai, with a view to recovering, if possible, the papers of Edward Vogel, who there met with his death. A former servant of Vogel's, and an eye-witness of his death, promises to accompany him.

Professor Lepsius, too, has gone to the northern coast of Africa, and has been fortunate enough to meet with a tablet of the same sort as the Rosetta Stone—*viz.*, an inscription in hieroglyphic and demotic characters, accompanied by a Greek translation, which will no doubt give additional confirmation and assistance to Ægyptologists. Besides these travellers, the Roman Catholic missionaries have published several works on the languages of Central Africa. The latest of these was published at Brixen, on the great pass from the Tyrol into Italy, and consists of a grammar and dictionary of the Dinka tongue.

The travellers educated in Africa (if we may so speak of the later life of one of these) carry into other continents the research and perseverance they have acquired in that remarkable quarter of the globe. Captain Burton, whose African exploits have made us almost forget his Asiatic deeds, has found a new sphere in South America. He has traversed the Rio Iguipe, and having discovered a volcano in a district (Brazil) hitherto considered devoid of these phenomena, he is intending, as soon as the weather will permit him, to continue his research. Further north, General Lyon, of the Southern States, has discovered one of the ancient cities of Mexico, the ruins, just as they were deserted, being surrounded and blocked up by trees.

We have to announce the death of Mr. John MacDougal Stuart, the explorer of a large portion of the Australian continent. After two journeys into the interior, he succeeded in crossing from Southern Australia to the north coast, a feat acknowledged by substantial grants from the colonial legislature, and Honorary Fellowships of the Royal Geographical Society of London, and that of Berlin.

Proceedings of the Royal Geographical Society.

A trustworthy account of the barbarous murder of Baron von der Decken, concerning whose fate we were in doubt when our last report was written, has been received through the British Consul at Zanzibar, Colonel Playfair. It will be remembered that the Baron had left his party in charge of a wrecked steamer, and had gone back to Berdera with Dr. Link. The camp in which this party remained was attacked by a band of Somāli, and Lieutenant Schickh, and those under his command, were compelled to descend to the coast, whence they hoped to send assistance to the Baron. In the meantime the latter lost his boat, and was separated from his companion. Both attempted to return to the wreck, in which attempt the Doctor was successful; but each was surrounded by the natives and barbarously murdered. The murderers are far from all European influence, and consequently not amenable to justice. The Sultan of Berdera is supposed to have connived at this cruelty. In connection with this subject a paper, by Colonel Rigby, was read on Englishmen in captivity in Somāli land, in which it was stated that there was a great probability that some of the crew of the St. Abbs Indiaman were still living in bondage among this people. It has since been announced that the Political Resident at Aden has commissioned a very intelligent Somāli, who has been interpreter in the police court, to return to his native country and determine positively whether any Europeans are there or not.

"Travellers' tales" have become proverbial for their untrustworthiness; but much as we are apt to distrust the accounts of men who have journeyed over ground not hitherto traversed, it is seldom that we find a case so glaring as that detected by Sir H. Rawlinson, of a lengthy account of a journey that was never undertaken. In a paper, entitled "Observations on a Memoir recently published by M. Veniukof, on the Pamin Region in Central Asia," Sir H. Rawlinson proved tolerably satisfactorily that M. Veniukof and the Russian geographers, as well as Kiepert and Stanford, had published maps and accounts of a little-known region lying between the northern frontier of Kashmir and the south of the Russian empire, mainly in reliance on a MS. journal of travels, discovered in the archives of the Military Topographical Depôt at St. Petersburg, purporting to be written by a German gentleman named Georg Ludwig von ——, who had been employed by the East India Company to purchase horses for them, but which MS. journal was a groundless forgery. The original work is described to be elaborately furnished with maps and sketches, to be accompanied by a French translation (in a separate volume) of the German original. The mention of an active volcano, north of Srinagur, in a well-surveyed province, where no such volcano is known—the traversing 120 miles of difficult mountainous country in two days, and other improbable distances—the mention of a Lieutenant Harvey, whose existence is unknown to the Indian Army List—the want of agreement of names with any that are known—the omission of the mention of Yaks or wild goats, and the mention of black rabbits, as yet unknown in Central Asia, with many other improbabilities, make the authority of the MS. rather more than doubtful.

The Leichhardt expedition into the interior of Australia has met with some reverses in the loss of all its horses, and in sufferings amongst the explorers from drought. The camels, however, survive, and the expedition will continue its work.

The Peninsula of Sinai has been well surveyed around its coast and in a line across its northern boundary, by the Rev. F. W. Holland, who holds opinions different from those of most travellers on the subject of the passage of the Israelites. In an interesting paper on the subject, the author described various roads, ruins, &c., discovered by him in unfrequented localities, bespeaking a period of considerable population and civilization in the interior of this now deserted peninsula.

The Sinaitic inscriptions and ancient turquoise mines (some of which have been mistaken for copper mines) yielded him some important results, and might be expected to produce more, if they were fully and carefully investigated. Owing, we suppose, to the influence of a prominent member of the Geographical Society, who constantly views with suspicion the politics of this region, Central Asia contributes a considerable share to the Proceedings. Captain T. G. Montgomerie, R.E., contributed a paper on a subject with which he was not personally acquainted—"The Geographical Position of Yarkund and other places in Central Asia." The circumstance which led this gentleman to be interested in this subject has been his employment in the trigonometrical survey of India by the Government; and whilst in this position he endeavoured to extend his knowledge beyond the limits of the country assigned to him. Whilst occupied in this manner he succeeded in becoming acquainted with a Moonshee, named Mohammed-i-Hameed, sufficiently instructed to be able to work ordinary surveying instruments and willing to convey those entrusted to his charge as far as was required of him. This man started and accomplished the main objects of his mission; but, unfortunately, was unable to return. He died within a short distance of the termination of this journey. His papers, however, were conveyed to Captain Montgomerie, who has obtained some very important results from them. Yarkund has proved to be in latitude 38° 19′ 46″; longitude, 77° 30′ E., and at an altitude of 4,000 feet; the distance from Jummoor is said to be 430 miles, so that the narrowest breadth of this portion of the Himalayan range cannot be estimated at less than 400 miles, a distance that it took the Moonshee fifty-one days to traverse, forty-five of which were spent at a greater elevation than 9,000 feet, and twenty-five at not less than 25,000. The climate seems to be severe; the mass of the people Mahommedan, though under Chinese rule.

Commander Forbes furnished a paper "On a Journey to the Western Shore of Volcano Bay in Yesso," which described the volcanic phenomena of this northernmost island of the Japanese empire, and gave an account of the Ainos, a race of hairy men supposed by some to belong to a different and more aboriginal race than the present Japanese, a position Professor Huxley to some extent controverts on the authority of similar conformation of skulls, which, though elongated, are distinct from the Esquimaux, and altogether unlike the crania of the races of Eastern Asia.

Other papers and communications read before the Society have been—"On the Settlement of Lukoja on the Niger," by Mr. T. Valentine Robins; A letter from Commodore Eardley Wilmot, Commander-in-Chief of the West African Station, "On the Niger Settlement;" "A Description of Peking," by Mr. W. Lockhart, M.R.C.S.; "On a Visit to Dana, in Tibet," by Captain A. Bennet.

At the anniversary meeting of the Society, the medals were awarded as follows:—The Founder's, to Dr. Thomas Thomson, M.D., for his exploration of the Western Himalayas and Thibet, and for his work thereon; the Patron's, to Mr. William Chandless, M.A., for his survey of the River Purus. M. Du Chaillu received one hundred guineas to reimburse him for the loss of his instruments in Western Africa.

Sir Roderick Murchison delivered a lengthy address, which alluded first to the deaths of Fellows during the last year. He then described the advance made of late in chartography and meteorological observation and registration. Dr. Livingstone has arrived at the mouth of the Livuma River, whence he will advance into the interior, to supplement, and as far as possible reconcile, the discoveries of Speke, Grant, Burton, and Baker. Mr. Whymper, of Matterhorn celebrity, accompanied by a well-trained Danish guide, is meditating a trip to the glaciers of the interior of Greenland. Central Asia is receiving much attention at the hands of Russian geographers, especially in the neighbourhood of the mountains lying between Little Thibet and Turkistan, a range which, for 450 miles, has peaks rising from 21,000 to 28,300 feet above the level of the sea.

VII. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

We cannot pretend to chronicle this quarter a very extensive list of new and important discoveries; but some few real advances have been made, and several questions of theoretical interest are still under discussion.

To begin, Dr. E. Percival Wright has made public the remarkable results of a systematic search for fossils at the Jarrow Colliery, Kilkenny, the expense of the exploration having been defrayed by a grant from the British Association. Professor Huxley and Dr. Wright have been able to distinguish in the collection made, species of no less than six genera of Labyrinthodonts, of which at least five, named respectively *Urocordylus*, *Ophiderpeton*, *Ichthyerpeton*, *Keraterpeton*, and *Lepterpeton*, are new, while the sixth may be the known genus *Anthracosaurus* of the Glasgow coal-field. The authors therefore justly remark, that "one Irish coal-pit has thus yielded, in the course of a few months, by careful exploration, more genera than are known from all the American coal-fields, and nearly as many as have been obtained from Europe generally." Besides these genera, however, there are indications of the existence of several others, as well as a large collection of fish-remains, including a new genus of ganoids, which is to receive the name of *Campylopleuron*. It appears that Ophiderpeton may be taken to represent either the type of *Amphiuma* or that of *Cæcilia* amongst existing Batrachia, while the rest fall into the salamandroid division, the better known genus *Archægosaurus* being the ancient representative of the Perennibranchiata. Consequently the tailless froglike form is the only one now unknown from Carboniferous strata, and, curiously enough, that is precisely the form in which the original genus Labyrinthodon was erroneously restored at the time of its discovery.

The recent eruptions in the neighbourhood of the Kaimeni Islands have afforded material for numberless newspaper paragraphs, and an excellent excuse for an agreeable trip to some half-dozen geologists and an untold number of tourists; but we are not aware that they have contributed much to our knowledge of volcanic phenomena. Heaps of lava, a new fissure, and even two new islands, though startling enough to those living in their immediate vicinity, have no special interest for the geologist, and those men of science who have visited the spot have either discovered very little of theoretical importance or have not yet made their discoveries known. We must, however, notice the report of M. Fouqué to the French Academy of Sciences, by which learned body he was sent to Santorin. From what he writes, it appears that neither the newly-formed George promontory of Nea Kaimeni nor the new island of Aphroessa is a true crater, but merely a heap of lava; that the eruptions have been on a very small scale and of an insignificant degree of intensity, and that the terror of the inhabitants was to a great extent created through the burning of a ship and the death of its captain by volcanic action. M. Fouqué also records the appearance of another new islet, to which he gave the name of Réka, situated in a line with the George promontory and the island Aphroessa. In consequence of the disengagement of combustible gases mixed with salts of soda from the lava of Aphroessa, that island has generally been enveloped in a yellow flame. If M. Fouqué is right in this respect, it is certain that under favourable circumstances volcanic eruptions may be accompanied by flame. To some it may appear extraordinary to question the fact, as the emission of flames is popularly supposed to be one of the chief characteristics of such phenomena; but it is well known that these apparent flames are merely the reflection of the colour of the liquid lava on the scoriæ and lapilli ejected by the volcano, consequently it has been doubted whether flames ever occur during an eruption, and even now it seems more probable that they occur *after* the event than that they accompany it.

Mr. Croll's speculations on cosmical causes of changes of temperature and on the submergence of the northern hemisphere during the Glacial Period have continued under discussion; but the nature of the controversy has somewhat changed, and the medium is now the high-class 'Philosophical Magazine.' The state of the case previous to this discussion may be thus stated:—Post-pliocene marine shells of an Arctic character have been found in England at various heights up to 2,300 feet above the sea-level, and this has ordinarily been considered a proof of submergence to that extent during the Glacial Period; but it has been thought a little extravagant by some geologists to suppose that the land could have been really upheaved so many hundred feet since so recent a date. Mr.

Croll's notion of an ice-cap is one of the ingeniously devised loop-holes of escape, which command admiration and deserve success. They obtain the first in abundance, the second in a very slight degree.

The March number of the 'Philosophical Magazine' contained a very elaborate mathematical paper by Mr. Heath, in which he showed that if Mr. Croll's theory "cannot explain elevations or depressions of 1,000 feet, it does teach us there is an agency at work in nature, which had perhaps been overlooked, which must be borne in mind in all speculations where tens of feet are material." We are very glad that Mr. Croll can be said to have done so much service incidentally. In the April number, however, Mr. Croll makes an onslaught on Mr. Heath, restates his theory of an ice-cap, and recalls one or two recantations he had previously made. His paper is followed by a note by Professor W. Thomson, who gives a formula for the calculation of the depression caused by the flow of water to the pole in consequence of the ice-cap altering the centre of gravity.

In the May number of the same periodical Mr. Croll was vigorously attacked by Mr. J. Carrick Moore and Professor Haughton; two assailants of undoubted power, both mathematicians and both geologists—a rare combination. It is quite obvious that the ice which Mr. Croll supposes to have "capped" the North Pole during the Glacial Period must have been derived either entirely from that now existing round the South Pole, or more or less from the water of the present seas. Mr. Carrick Moore assumes, in the first place, that the ice was obtained at the expense of the sea, and shows that an ice-cap, as supposed by Mr. Croll, of 7,000 feet thickness at the pole, would, on this view, cause at lat. 60°, a *depression* of the sea level, not an elevation, to the extent of 833 feet, in consequence of the drain of sea-water exceeding the elevation caused by the attraction of the ice-cap to that extent. Secondly, he proves that if the ice which formerly existed in the northern hemisphere had been derived from the southern, and has now returned there, an ice-cap of a uniform thickness of 2,000 feet over the Antarctic regions, which is certainly an exaggerated estimate of the existing ice, would not supply one-twentieth part of that required to cause a submersion of the land at lat. 60° to the extent of 2,300 feet. Finally, Mr. Carrick Moore observes that, "as the quantity of ice to be supplied by the melting of that at the south pole is so greatly disproportionate to its object, it is unnecessary to discuss what appears to me to have been too lightly assumed—*viz.* that when one pole is under glacial conditions, the opposite will be entirely free from ice."

With respect to Mr. Croll's notion of the eccentricity of the earth's orbit being connected with changes of climate, the Rev.

Professor Haughton remarks that the law received by astronomers is—"That the quantity of heat received per annum from the sun varies inversely as the minor axis of the orbit," that is to say, the heat *increases* with the eccentricity. Mr. Croll's view* was based on a contrary opinion—namely, that the greater the eccentricity the colder the climate. In point of fact, however, he has not only to prove that astronomers are wrong, but also that the difference in temperature owing to the eccentricity of the orbit is sufficiently great to be the determining cause of a Glacial Period.

It is satisfactory to learn that the conclusions of mathematicians respecting the ice-cap theory correspond with those arrived at by a study of facts. Indeed, Mr. Croll has never yet, we believe, attempted to show that the known phenomena of the Glacial Period square with his theories; and unless he can do that, they would not advance us a step, no matter how beautifully symmetrical or mathematically exact they might be. At present we are merely discussing whether they are extraneously possible; their intrinsic probability is quite another question.

Mr. John Evans, of flint implement celebrity, has lately propounded before the Royal Society another theory of the cause of supposed changes in the earth's axis of rotation. He takes the case of a sphere consisting of a mass of viscid or fluid matter, surrounded by a crust of inconsiderable thickness, and in a condition of revolution about a given axis. He then supposes the equilibrium to be disturbed by the protrusion of a portion of the crust somewhere between one of the poles of the sphere and its equator. The result would be, as Mr. Evans states, that the greater centrifugal force possessed by this protruded portion would tend to bring it towards the equator, and thus alter the axis of rotation of the external crust, which would adjust itself about the internal plastic and still spherical mass within. The rotation of the sphere and this excess of centrifugal force possessed by the protruded portion would cause the latter to describe a spiral, as it were, of gradually increasing dimensions, until at last it became in the line of the equator of the sphere, and described a circle, when the axis of rotation would again become fixed until some fresh cause of disturbance produced a repetition of the process. In the same manner Mr. Evans supposes the upheaval of large mountain-masses to have operated on the earth's axis of rotation, the only distinction he draws being that, from the spheroidicity of its figure, there would be more difficulty in the crust adjusting itself over the fluid nucleus. This theory looks very plausible, but if we inquire a little further into the case of the supposed sphere, we shall get an indication of the kind of difficulty it fails to meet when applied to the earth. Imagine a second mass to be protruded after the first shall have

* 'Phil. Mag.,' Jan., 1866.

arrived at the equator. Before we had to deal with a sphere having no tendency to revolve on one particular axis more than on another; but now there is resistance to be overcome—a resistance intensified by the rotatory motion of the sphere. So, in the case of the oblately spheroidal earth, for a mountain-mass to affect the axis of rotation it must possess a centrifugal force sufficient to overcome the resistance presented by that of the greater protrusion of the earth at the equator, that protrusion being equal to a belt 6½ miles thick at the equator.

For some months past geologists have been awaiting with curiosity the publication of the details of an alleged discovery of Bracklesham fossils in beds beneath the Landénien inférieur (Thanet sands) of Belgium. It was felt that if this discovery were really such as it was represented to be, the "Colony" principle must be admitted as an essential element of uncertainty in the determination of the age of a stratum from the evidence of its fossils. Now that MM. Cornet and Briart's paper has been published,* we are in a position to judge of the value of the evidence on which this asserted discovery rests. It appears that a well-section at Obourg, near Mons, revealed sandy beds underlain by limestones, and that these limestones yielded twenty-two species of Bracklesham (Calcaire Grossier) fossils, with about 120 others, mostly new. The sandy beds are considered to be identical with those near Angres and Tournay, which yield *Pholadomya Koninckii*, and are therefore of Landenian age. The proofs of this identity rest partly on a certain amount of lithological correspondence, and partly on sections which seem to prove the uninterrupted continuity of the strata from one locality to the other. But it does not appear that *Pholadomya Koninckii* has yet been obtained from the same section as the Bracklesham fossils. After an endeavour to weigh this evidence impartially and without prejudice, it appears to us that the following is a fair conclusion:—The evidence would be sufficient to establish, until disproved, the position assigned to these fossils by MM. Cornet and Briart, if no violation of previously received geological principles were involved; but, under existing circumstances, this Tertiary "colony" cannot be considered authentic until *Pholadomya Koninckii*, or some equally conclusive fossil, has been found in direct superposition to the Bracklesham shells. Even then the case would seem to be as good for an extension of the range of *Pholadomya Koninckii* as for the "Calcaire Grossier" colony.

The 'Geological Magazine' for the past three months contains

* "Note sur la découverte dans le Hainaut, en dessous des sables rapportés par Dumont au Système Landénien d'un Calcaire grossier avec faune Tertiaire." Par MM. F. L. Cornet et A. Briart. 'Bull. Acad. Roy., Belgique,' 2me série, vol. xx., no 11.

so many interesting papers, that our space will not allow us to do justice to them all. In the March number, Mr. S. V. Wood, jun., concludes his memoir on the structure of the Thames Valley. His conclusions are rather heterodox, and could only be understood after a careful perusal of the paper. The most remarkable inference is that the south side of the Thames Valley was subjected to violent convulsions after the deposition of the brick-earth deposits, and the author gives sections showing several faults of very recent date. He also states that in the present Thames Valley there is "nothing analogous to terrace-formation, or to the modification of an estuary by the successive elevation of the land and cutting down of its bed, until the estuary has become a river." He considers the brick-earth deposits to be of three different ages, and the "upheaval of portions of the original valley, the dislocation of its deposits, and the extensive denudation of the uppermost of them," &c., to have taken place after the deposition of the newest of the three. These and many other conclusions are contained in a paper of about thirteen pages, and if Mr. Wood finds that geologists do not accept them, he ought not to be surprised. It would require all those thirteen pages to prove conclusively one of his inferences—*e.g.* that the brick-earths of the Thames Valley are of three distinct ages. There is hardly a fragment of evidence, whether palæontological, strategraphical, or lithological, given in support of a single statement; and it really appears as if the author considered matters of fact too trifling for publication. We recommend Mr. Wood to expand his thirteen pages into a couple of hundred, and give in full the evidence on which his conclusions rest.

Professor Phillips describes a new species of *Libellula* from the Stonesfield slate, and starts the question whether the Oolitic insects "manifest any special affinity with congeneric forms now visible in Australia, as do the Cycads, *Waldheimia*, *Trigonia*, *Cucullæa*, and *Phascolotheria*, which are their companions in the deposits of Stonesfield, with the plants, shells, and mammals of that old-fashioned corner of the earth." This is a captivating inquiry for an entomologist, and we hope it will be taken up by a competent authority.

Mr. E. C. H. Day gives a paper "On an Ancient Beach and a submerged Forest near Wissant," and another "On a Raised Beach and other recent formations near Weston-super-Mare." In the first paper Mr. Day asks, "Why has Wissant ceased to be a Port?" and he suggests that it is not because "the *growth* of the sand-dunes had obliterated its harbour," but because of the harbour having been silted up, the shoal which formerly acted as a natural breakwater having been gradually destroyed. The description of the raised beach is also interesting in connection with the questions recently discussed by Mr. Prestwich in describing the neighbouring beach of Sangatte.

In the April number, Captain Hutton gives an interesting sketch of the geology of Malta, and Professor Rupert Jones adds some notes on the fossils from each of the strata described. The Rev. P. B. Brodie contributes a paper "On a Deposit of Phosphatic Nodules in the Lower Greensand at Sandy, Bedfordshire." Mr. Mackintosh supplements his paper, "The Sea *versus* Rain and Frost," by one entitled "The Sea against Rivers; or, the Origin of Valleys." Mr. Wyatt Edgell describes a new *Lichas* from the Llandilo Flags; and Professor Church gives a note on Chinese figure-stones. We should have been tempted to discuss Mr. Mackintosh's paper had it not been ably met by a paper in the May number from the pen of a very eminent geologist, Mr. Poulett Scrope, M.P. The author's arguments are chiefly drawn from the Auvergne district, and he conclusively shows how great has been the influence of "Rain and Rivers" in scooping out valleys in that district. He also adds that they have done their work "wherever land lay exposed to their influence above the protecting surface of the great waters." But Mr. Scrope is not a red-hot partisan, as will be seen by his concluding sentence: "The object of this paper is simply to suggest that the two denuding agencies have been always at work upon the surface of the earth, and that there is ample reason to consider the one to have produced effects quite as considerable as the other."

Professor Owen gives, in the same number, a description of a new Mammal (*Stylodon pusillus*) "nearly allied to *Spalacotherium tricuspidens* (Ow.), and from the same formation and locality, *viz.* the Marly bed, Upper Oolite, Purbeck, Dorsetshire." The locality and horizon appear to be rather indefinite, and would scarcely be understood but for the reference to *Spalacotherium*. Mr. H. M. Jenkins notes the occurrence of *Trigonia Lamarckii* (a recent species) in the Tertiary deposits of Victoria, which he considers of importance because of its bringing the Oolitic and recent types of the genus into such close proximity. Mr. H. Woodward records the occurrence of *Ceratiocaris* in the Wenlock Limestone, and Mr. T. M'Kenny Hughes adds a "Note on the Silurian rocks of Casterton Low Fell, Kirkby Lonsdale, Westmoreland," one of the localities which yielded the specimens of *Ceratiocaris* described by Mr. Woodward. There is also a paper "On the Junction of the Chalk with the Tertiary beds in East Kent;" but, like many of its associates, we must pass it by without further notice.

Proceedings of the Geological Society.

A very bulky number of the Society's journal contains this quarter a very insignificant instalment of the Society's proceedings, more than half of it being taken up with the Annual Report and the

President's address. The report represents the society to be in a very flourishing condition, both numerically and "financially." The address contains notices of a large number of the more important geological works that were published during 1865; but as most of them are by this time familiar to our readers, we shall not stop to discuss them. We cannot, however, refrain from noticing an opinion, which is very heterodox, but which, nevertheless, may one day turn out to be valuable, perhaps premonitory of a great discovery. Mr. Hamilton (the president of the society) thinks "that the time is come when it is desirable to investigate this question—Whether the theory of central incandescent heat is tenable?" So far so good, except that it seems difficult to imagine heat itself as "incandescent;" but the sequel is extraordinary—namely, "Whether the plastic condition of the earth, to which its oblate spheroidal form has been attributed, be not owing to an aqueous rather than to an igneous origin?" Mr. Hamilton further enunciates the following problem as a corollary:—"Whether the formation of the earth may not have commenced with a central nucleus consisting of an aqueous paste, gradually increasing in size as matter was deposited around it from the circumambient fluids and gases which filled the solar space before solid matter was aggregated round those spots which now form the planets in our solar system?" Mr. Hamilton suggests these and other questions for the consideration of the society; but the inquiry is purely one for physicists and astronomers.

Two out of the three papers contained in the same number of the 'Quarterly Journal' are deserving of notice. In the first, "On the Western Limit of the Rhætic Beds in South Wales, and on the Position of the Sutton Stone," Mr. E. B. Tawney shows that the Rhætic beds are continued as far westward as near Pyle, west of Bridgend; and that the Sutton stone and some beds above (named by him the Southerndown series), which occur at and near Dunraven Castle, Sutton, &c., do not belong to the Lias but to the Rhætic beds. He also expresses the opinion that the Sutton beds are slightly anterior in time to the *Avicula-contorta* series, so that his discovery of *Ammonites* in them is of somec onsiderable importance. In a note to this paper, Dr. Duncan gives more decided evidence respecting the age of the Sutton beds as the result of an examination of the corals. He states that these corals "in the Alpine Trias would be deemed St. Cassian," and the only consideration which induces him to make any reservation about the St. Cassian age of the Sutton beds, is the defective nature of our information respecting the range of the St. Cassian corals, and their relation to those of the Dachstein and Kössen strata. If further researches confirm the high antiquity here suggested as belonging to the Sutton beds, a zone of life will have been discovered in

England by Mr. Tawney, which has hitherto been supposed to be confined in Europe to the Triassic districts of the Alps.

The only other paper we shall notice is that by Dr. J. W. Dawson, "On the Conditions of the Deposition of Coal, more especially as illustrated by the Coal-formation of Nova Scotia and New Brunswick." The title of this paper is very unfortunate and very deceptive, for so far from the author believing in the "deposition" of coal, he contends that the occurrence of *Stigmaria* under nearly every coal-bed proves beyond question that the material of the coal was accumulated by a growth *in situ*, and this reasoning has always obtained the full consideration to which it is entitled. Dr. Dawson's paper treats of so many other points that in a chronicle of this nature it is impossible even to enumerate them. Amongst these is the contrast afforded by the characters of the intervening strata to what is yielded by those of the coal and the underclays—namely, while the latter prove the growth of the coal *in situ*, the former prove the abundant transport of mud and sand by water; that is to say, the conditions employed are such as prevail in the swampy deltas of great rivers. One subject touching on the philosophy of geology is discussed by Dr. Dawson with great effect—namely, the bearing of the lithological characters of the successive beds in each great formation on the interpretation of the sequence of events which occurred during their deposition, and his opinion is, that we must regard each of the great formations as the evidence of a period "presenting during its whole continuance the diversified conditions of land and water, with their appropriate inhabitants," and "as forming a geological cycle, in which such conditions were to a certain extent successive." In conclusion, we may state that this is a capital paper, philosophically conceived and carefully executed.

VIII.—MINING, MINERALOGY, AND METALLURGY.

Mining.

Tin and copper mining were never in a less profitable state than they are at present in this country. There are scarcely ten mines in the United Kingdom, producing those metals, which are not at the present time working at a loss. The aspect around is gloomy; nowhere does there appear a bright spot to kindle hope.

Never during any one year has there been a larger quantity of tin ore raised from the mines of Cornwall and Devonshire than during 1865. This rash process continues, and the tin ore sales of last month were larger than in any previous month, with one solitary exception. The consequences of the American civil war led to an extinction of the tin-plate trade, and thus greatly reduced the consumption of tin. This produced naturally a reduction of price. Upon this the Cornish mines,—for the purpose of maintaining their dividends, preventing calls, and keeping the miners, who have long shown a disposition to emigrate,—have been made to yield a quantity of tin ore, much in excess of the requirements of the manufacturer. At the same time, tin, in unusually large quantities, has been thrown into the English market by the Dutch speculators. Banca and Billiton tin have, from their having improved in quality, and being cheaper, taken the place of English tin, in many of our large works. At the present time the price of tin ore is not sufficient to pay the expenses of producing it, yet the mines continue to press their ores upon the smelters, in the face of a serious present loss and a too evident future failure, which must be ruinous. A monthly metal circular now before us says:—"We have received about 2,000 slabs of Straits tin from America, and there is little chance of any demand for export hence to that country; while, owing to the stagnation of the tin-plate trade, consumption of tin must have fallen off, and will continue to do so for the next two months." The quantity of tin here and in Holland on the 31st of May was as follows, compared with the three preceding years:—

	Tons.
1866	10,457
1865	10,000
1864	8,690
1863	6,815

In the face of the continental disturbance which threatens, we cannot dare to hope for a better report in our next.

The copper mines suffer from other causes than those influencing the tin mines. The present price of English tough cake copper is 19*l*. per ton below the average of the last sixteen years. The influences through which this state of things has been brought about are not clear. It has been referred to the failure of the usual demand for copper in India; but this appears quite insufficient to create this extreme depression. Our supplies of copper from Chili have fallen off in consequence of the war with Spain, and for some time to come we cannot expect any large quantity of copper from that country. The deficiency will certainly not be made up by any increased supplies from other parts of the world. We may, consequently, hope, in a little time, to see our English copper mines becoming more profitable than they have been for some time past.

	Tons.
The tin-mines of Cornwall and Devonshire produced, in 1865, of Black Tin (Tin Ore)	15,686
The production in 1864 having been	15,211
The quantity of Copper Ore produced from the mines of Cornwall and Devonshire in 1865 was	159,406
The production in 1864 being	163,336
The Swansea sales of Irish, Welsh, and Foreign Copper Ores were, in 1865	25,217
Against, in 1864	32,413

Our notices of mining operations in other countries must necessarily be brief. A considerable degree of excitement has been created in relation to mining in California, and not a little, especially in America, in connection with the development of the wonderful Lake Superior district.

By the courtesy of the proprietors, we have been favoured with copies of the 'American Journal of Mining,' published in New York. This new periodical, embracing "Milling, Oil-boring, Geology, Mineralogy, Metallurgy," &c., has a sufficiently expanded field for its labours. Within the United States territory, nearly every metalliferous and earthy mineral has been found. The extent of the American coal-fields is vast, and roads and railways are rapidly opening out districts from which the supply of fuel can be abundantly obtained. A new industry has been created in the oil regions, and the rapidity with which the iron manufacture of the United States is expanding, shows that such a journal as that now before us, if conducted with strict honesty of purpose, must become important, equally to the miner, the metallurgist, the manufacturer, and the public. The 'American Journal of Mining' evidently takes the 'Mining Journal' of this country as the example it would follow. Reports on mines and mining, correspondence on these, on metallurgy and mineral manufactures, with notices of these sciences which bear upon any of those industries, and a very extensive share-list, form the bulk of the papers yet issued.

Amongst the original papers, those on "Petroleum," by Professor Francis E. Engelhardt, promise to be as valuable and instructive, as they are interesting. From the "Mining Statistics," by Dr. R. P. Stevens, we abstract the following particulars relative to several branches of mining and metallurgy:—

The rapid increase of mining and metallurgical works in America are a striking proof of the rapid development of those important industries in that great continent.

We find it stated in United States' official documents that there are now 157 mining establishments engaged in raising iron ore, employing 3,177 men. There are 97 bloomaries, 286 furnaces, 256 rolling mills, 16 mills for drawing iron wire, 17 car-wheel manufactories, 1,412 establishments for castings, 19 for locomotives, 74 for sewing-machines, 239 for arms, 443 for hardware, 382 for steel, 99 for nails, 134 for scythes, and 14 for printing-presses.

Copper.—There are 42 mining establishments in Michigan, New Mexico, Tennessee, and North Carolina, producing 499,534 tons of ore.

Coal.—In round numbers the production is stated at 15,000,000 tons. In our last, we gave it from a strictly reliable source as 14,593,659 tons. The collieries employ 36,469 workmen.

Lead and Silver.—Lead mining and smelting are stated to have produced about 12,000,000 dollars, and silver about 5,000,000 dollars.

Gold.—7,202 mining establishments are reported. These are situated in California, New Mexico, Oregon, North Carolina, Georgia, Virginia, and South Carolina, placing the States in the order of their productiveness. The gold they produced is given as 47,566,000 dollars.

Those who are interested in the mode of occurrence of petroleum may obtain a large amount of information by referring to the 'Proceedings of the American Philosophical Society for May, 1865,' in which will be found a very satisfactory description of the petroleum deposits in the eastern coal-field of Kentucky, by Mr. T. P. Lesley.

The general condition of an "Oil" country is thus described. Mr. Lesley is writing especially of the neighbourhood of Paint Lick Creek, Kentucky. "Petroleum is the mineral that excites most interest at present in all this region, and the show which it makes upon the surface is extraordinary. It issues in numerous places from the base of the cliffs which form the walls of the cañons, through which flow the main Paint and its many branches. It saturates the slopes and banks of loose sand. It flows off, when the sand is stirred with a stick, as a shining scum upon the surface of the stream. It has been caught against booms and barrelled for sale. It unites, also, with the sweepings from the sub-conglomerate ore and coal shales, and forms slimy ore-bogs and muck-heaps, where the base of the conglomerate is at any greater height than usual above the water-bed, and the slope from it is therefore longer than usual. Such is the case at the Old Oil Springs, on the north line of the May and Ross Survey, where it crosses the Little or South Fork of Paint; and again 200 yards lower down, at Pendleton's Oil Springs.

"A black reservoir of tar-like oil here occupies the centre of a sloping bog, and is kept always full from a spring at its upper limit, near the top of the slope and the foot of the cliffs, about twenty feet above the level of the stream."

A remarkable extension of shale mining for the production of petroleum is also taking place in this country. More than 100 retorts have lately been set to work in North Staffordshire. In Derbyshire and in Yorkshire many works are rapidly progressing towards completion, for the distillation of oil. All the old works in Flintshire are actively distilling cannel coal and shale; and in addition to the established works in Scotland, using the Torbanehill mineral, several others are starting. The consequent enormous production of "coal oil" in this country, added to the immense importation of petroleum from America, must lead to a great reduction of price, and an extension of its use for illuminating and lubricating purposes.

The coal production of this country, as we learn, shows but a slight increase in 1865 over the production of 1864. A considerable excitement has arisen on the "Coal Question" since Mr. J. S. Mill drew attention to Mr. Stanley Jevons' book in the House of Commons. In this journal Mr. E. Hull has already dealt with the subject.

On the 12th of June Mr. Hussey Vivian moved, in the House of Commons, "that an humble address be presented to Her Majesty, praying that she will be graciously pleased to issue a Royal commission to investigate the probable quantity of coal contained in the coal-fields of Great Britain, and to report on the quantity of such coal which may be reasonably expected to be available for use; whether it is probable that coal exists at workable depths under the Permian, New Red Sandstone, and other superincumbent strata, and whether they would recommend that bore-holes should be sunk in any and what localities; to ascertain and report on the quantity of coal at present consumed in the various branches of manufacture, for steam navigation and for domestic purposes, as well as the quantity exported, and how far and to what extent such consumption and export may be expected to increase; how far the increase of population must necessarily accord with the increased consumption of coal, and the relations which one is likely to bear to the other; and whether there is reason to believe that coal is wasted either by bad workmanship, or by carelessness, or neglect of proper appliances for its economical consumption, and whether they would recommend legislation, with a view to avoid such waste."

After an interesting debate on this important subject, in which all agreed that an inquiry was necessary, Sir George Grey said, "The Government thought it desirable to associate with the chief members of the Geological Survey Department, men of great practical knowledge and experience in the working of mines and manufacturing operations, with a view to a searching and impartial inquiry, in the result of which the country might place confidence. They thought that the commission should consist of a mixed body, and include men of the highest scientific attainments, among whom he hoped Sir R. Murchison would allow himself to be placed. Upon that understanding the Government were prepared to agree to the motion."

We may, therefore, hope that the "Coal Question" will receive a satisfactory solution.

Mineralogy.

The most important contribution to this science during the quarter has been Bernhard von Cotta's 'Treatise on Lithology'* in

* 'Rocks Classified and Described: a Treatise on Lithology.' By Bernhard von Cotta. An English edition, by Philip Henry Lawrence. Longman, Green, & Co.

its English form, for which we are indebted to Philip Henry Lawrence; the translation, however, being revised by the author. The original work of Cotta is well known. Opinions vary widely as to its merits, but it has passed through two German editions, and a third is in preparation.

This alone speaks loudly in favour of a work which is purely scientific, and may be accepted as the best possible testimony to its general merits. Professor Cotta informs us—"This English edition may be considered as the third edition of my original work, although, if the appearance of a third German edition should be delayed for some time longer, there will doubtless be new matter and fresh alterations to be introduced; for science marches with uninterrupted steps towards new fields of discovery, and every year alters its aspect. In a system of lithology, however, most of the names which are in use will probably remain, and one chief object of this book is to define these so as to render intelligible the ideas which each name should convey, and both author and translator are actuated by the desire and ambition of arriving, as far as may be possible, at a common ground for all nations in respect of the important matter of rock nomenclature."

A careful examination of this important work must be reserved, and will probably be presented to our readers on a future occasion; it is sufficient now that we have directed attention to the first appearance in the English language of a comprehensive treatise on Lithology.

The following mineralogical works have appeared during the quarter:—'Die Minerale der Schweiz,' von Dr. Adolf Kenngott. Leipzig. 1866.—'Vorlesungen über Mineralogie,' von Kokscharow. 1 Band. St. Petersburg. 1865. (Received by us not until March, 1866.)—'A Catalogue of Siberian Topazes,' by Kokscharow. St. Petersburg. 1866. (Written in the Russian language.)

Analyses of *Rahtite*, of *Marcylite*, and of *Moronolite*, by Mr. S. W. Tyler, are given in 'Silliman's Journal,' by Professor Charles U. Shepard.* *Rahtite* was distinguished as a new species by Mr. Tyler in 1861, during a survey of the Ducktown copper-mines, Tennessee. It is found associated with melaconite, chalcopyrite, and Redruthite, in the decomposed portions of the great copper lodes of these mines. The colour of the mineral is a dark lead-grey, with a tinge of blue, not unlike some of the ores of antimony. Its structure is massive, though at first inspection it seems highly crystalline; but this deceptive appearance arises from its being traversed in all directions by slender prismatic cavities, imparted to it by some unknown mineral which has wholly disappeared. The walls of these cells are polished and bright.

The analysis of Rahtite, which is so named after Captain Raht,

* 'The American Journal of Science and Art,' No. 122.

the manager of the principal Ducktown mines, gives its composition as:—

Sulphur	33·36
Copper	14·00
Iron	6·18
Zinc	47·86
	101·40

Marcylite, a mineral already described in Shepard's 'Mineralogy,' but not hitherto obtained in a pure state, is, according to Mr. Tyler's analysis:—

Sulphide of Copper	47·70
Sulphide of Iron	2·86
Oxide of Copper	39·70
Sulphate of Copper	2·13
Water	9·00
	101·39

The name given to this copper ore is unfortunately like Marceline—one of the oxides of manganese, for which, by its name, it may be mistaken.

Moronolite appears to be nearly identical with Gelbeisenerz and Jarosite, a potash-copperas,* the only peculiarity being that while the two last have each but one of the alkalies, they are both present in Moronolite.

Professor Shepard† calls attention to a mineral found in the old workings of the Southampton lead mine in Massachusetts, which proves to be *Scheeletine*, a tungstate of lead. He also notices the discovery of Uwarowite,—a lime-chrome-garnet,—from Wood's chrome-mine, Texas, Pennsylvania.

Professor E. J. Chapman, of Toronto, writes of the discovery of native lead in some mines on the north-west shores of Lake Superior. Native lead has been found by the late Captain Stephen Eddy, in the mines of the Duke of Devonshire, in Yorkshire.

A new arseniate of zinc, called after M. Adam, *Adamite* ‡—the crystal, first examined by M. Friedel—having been found in the cabinet of that mineralogist,—has been brought to the notice of the Academy of Sciences of Paris. The specimen was from Chili, and was mixed in a mass of native silver with Limonite. Chemical analysis showed it to consist of:—

Arsenic Acid	59·95
Oxide of Zinc	34·32
Protoxide of Iron	1·48
Oxide of Manganese	a trace.
Water	4 55
	100·30

* See 'Bristow's Glossary of Mineralogy.'
† 'American Journal of Science and Art,' No. 122.
‡ 'Comptes Rendus,' No. 12, p. 692.

These numbers accord with the formula As Zn^2 H θ^3; while, at the same time, the crystalline form shows the most complete isomorphism to exist between this new substance and Olivenite and Libethenite.

Sir David Brewster brought before the Royal Society of Edinburgh a very fine specimen of fossil amber discovered in the kingdom of Ava. Mr. T. C. Archer also called the attention of the Society to a new bituminous substance imported into Liverpool from Brazil. This bituminous shale was submitted to the examination of Dr. Edwards, who declared it to contain a larger quantity of oil than the Torbanehill mineral. Some specimens of bituminous schists were exhibited in the Brazilian collection in 1862; from one of the localities then named, this specimen is supposed to be derived.

In a letter read by M. St. Claire-Deville, at a meeting of the Academy of Sciences, M. Wöhler described a new mineral from Borneo. This mineral, for which the name of *Laurite* is proposed, is a sesquisulphide of Ruthenium combined or mixed with sulphide of Osmium. Laurite is found in the form of small globules having slight appearance of crystallization. In colour and brilliancy it resembles crystallized oligist. An analysis of Laurite gave:—

Ruthenium	65·18
Osmium	3·03
Sulphur	31·79

This mineral—which appears to be the first example found of a natural sulphide of the platinum group—is not attacked by either nitro-muriatic acid, or by bisulphate of potash at a red heat. It fuses, however, with hydrate of potash and nitre, forming a brown mass, which gives a fine orange-coloured solution.

M. Berthollet has recently published a new hypothesis on the origin of carburets and the combustible minerals.* Although those combustible minerals, which obviously result from the transformation of organic matter, admit of explanation, there are others which are not so produced, as the carburets observed in the products of volcanic eruptions, and such as have been detected by M. Daubrée in meteorites, which require some other explanation. M. Berthollet supposes carbonic acid, penetrating the crust of the earth, is brought in contact with the alkaline metals at a high temperature, that thus acetyl is first formed, which undergoes a series of reactions, giving rise to the almost infinite series of hydro-carbon compounds. We must refer our readers to the original communication and to M. Berthollet's previous experiments.

M. Pisani in one of the last *séances* of the Académie des Sciences presented a note upon a new mineral, which had been especially examined by M. Adam. It is an arseniate of copper, but differing

* See 'L'Institut,' May 16, 1866.

from the arseniates which had been analyzed by Bournon, Haüy, and Beudant, in containing a notable quantity of oxide of iron. Amongst the analyses which have been made of *Aphanese* or *Clinoclase* as it was supposed, was one by Chenevix, which gave arsenic acid 33·5, oxide of copper 22·5, oxide of iron 27·5, water and sand 15·0. This was suspected to be an error until Mr. Adam analyzed a specimen for M. Pisani, and proved it to be a species different from the other arseniates of copper. His analysis was:—

Arsenic Acid	32·20
Phosphoric Acid	2·30
Oxide of Copper	31·70
Oxide of Iron	25·10
Lime	0·34
Water	8·66
	100·30

To this mineral, which so nearly approaches the arseniate of copper analyzed by Chenevix, it is proposed to give the name of *Chenevixite.* It is found in little compact masses in the quartzose rocks of Cornwall. They are usually so interpenetrated with the gangue, that it has been impossible to separate the one completely from the other; thus the density which has been obtained is only approximate, namely, 3·93; its hardness being 4·8. It is opaque, with a conchoidal fracture, and of a dull-green colour passing to yellow.*

A peculiar example of a physical change in a diamond has recently been brought under the notice of the Académie des Sciences of Paris. M. Frémy exhibited at the meeting on the 7th of May a diamond weighing more than sixty grains, which at the ordinary temperature is lightly shaded yellow, but which, when submitted to the action of an elevated temperature, assumed a rose tint, which it preserved for several days, returning gradually to its normal yellow tint. This diamond being rose-coloured at one *séance*, will, if preserved in the cabinet of the Institute until the next *séance*, again exhibit its original yellow colour. The ordinary price of a diamond of this weight would be about 60,000 francs; with the rose-colour, if this was permanent, the value would be at least tripled. We believe this is the first example of a diamond of variable colour.

Professor J. D. Whitney† has been examining Clear Lake in California and its neighbourhood. This lake is sixty-five miles north-west of Suisun Bay, and is about twenty-five miles long. On the south-west side of a narrow arm of this lake is a small lake about two-and-a-half miles in circumference, known as the "Borax Lake." From the waters of this lake, evidently of volcanic origin, there can be extracted, without much trouble, a large quantity of

* 'Les Mondes,' April 12, 1866. 'Comptes Rendus,' No. 12, p. 690.

† 'Geological Survey of California,' by J. D. Whitney, State Geologist.

borax in the condition of nearly absolute purity. The value of this discovery is great indeed. We have seen natural crystals of borax from two to three inches in length brought from this remarkable region. We understand that an English chemist is now engaged in investigating the matter, and there is no doubt but in a short time, by either English industry or American energy, this new source of borax will be brought into active rivalry with the lagoons of Tuscany. Indeed, a "California Borax Company" is already formed.

A new source of the metal *Indium* has been found by Dr. Kachler in the zinc blende of Schoenfeld, near Schloggenwald, in which mineral it is associated with tin and other metals in such proportion that some grains of it can be separated. The blende is roasted, dissolved in sulphuric acid, and the solution treated with metallic zinc, the Indium is then precipitated with the other metals, from which it can be ultimately separated.

M. Henry Soliel has presented to the Académie des Sciences of Paris a memoir "Upon the Direction of the Optical Axis in Rock Crystals." This is a very elaborate examination of this optical question, to which M. Henry Soliel appears to have found a very perfect solution. This memoir will appear in the 'Comptes Rendus' of the Academy.

Leuchtenbergite is the name of a mineral, to which the Duke Nicholas of Leuchtenberg has recently drawn the attention of the Academy of Sciences of St. Petersburg, with a view to remove the uncertainty which surrounded it. Breithaupt considered it as an altered *Chlorite;* Komonen found but 8·62 per cent. of water; Cloizeaux regarded this mineral as a variety of *Pennine;* while Nauman regarded it as a variety of *Clinochlore.*

The Leuchtenbergite is found near Slatoust and in the mountains of Chichime in the Ural. It is a talc-like mineral, with a hardness of 2·5 and a density of 2·61. The analysis of the mineral gives:—

Silica	30·60
Oxide of Iron	2·02
Lime, Magnesia	34·41
Alumina	19·63
Water	12·76
	99·42

This is nearly the composition of Clinochlore; but its physical characteristics induce the Duke of Leuchtenberg to regard it as a distinct variety, appertaining to the group of Chlorites.

Dr. Heddle communicates to the 'Philosophical Magazine'* the following notice of a British variety of Wulfenite:—

* 'Philosophical Magazine,' April, 1866.

"Greg and Lettsom doubt whether or not Wulfenite may rank as a British species. In Thomson's 'Mineralogy,' vol. i., p. 565, we find the following remarks on a specimen (a single specimen) in the possession of the Stockholm Academy:—'It was ticketed *lead spar*, from Mendip, near Churchill, in Somersetshire; it was chiefly carbonate of lead, but it contained two portions of a yellower colour than the rest, which attracted the particular attention of Berzelius.* One of them being examined by the blowpipe proved to be molybdate of lead; the other portion was an oxychloride of lead.'

"This, so far as I know, is the only published record of the occurrence of this substance in Britain. Lately a new pit was sunk for some thirty fathoms at the 'South of Scotland Mines,' at Lackentyre, near Gateshead, in Kirkcudbrightshire, and amongst many interesting minerals brought me thence by Mr. James Russel, of Airdrie, there was a single specimen of the molybdate. The associated minerals are galena, carbonate and phosphate of lead, and cupreous calamine; the molybdate occurs in well-pronounced and unusually brilliantly polished crystals of about $\frac{1}{8}$ inch in size; the crystals are thin, transparent, and bright yellow. The pit in which this specimen was found proved unproductive, and has been abandoned; there is thus little hope of others being obtained."

Our Mineralogical notices would not be complete without a record of the following papers:—"Über den Titanit im Syenit des Plauen'schen Grundes," von P. Grosh.†—"Über der Natur der Silicate," von Dr. Mohr.‡—"Neubildung von Schwefelkupfer in vergelbtem Papier alter Bücher," Kerner.§—"Mineralogical Correspondence."‖—"Kondroarsenit, ein neues Mineral."¶—"Alloklas, ein neues Mineral."**—"Über den Klipsteinit, ein neues Mangansilicat," von Prof. Kobell.††—"Preisaufgabe aus dem Gebiete der Mineralogie."‡‡—"Mineralogische Studien," von Breithaupt.§§

M. Daubree has published 'Expériences synthétiques relatives aux Météorites. Rapprochments auxquels ces Expériences conduisent, &c.;"‖‖ and M. Boussingault writes,¶¶ "Sur la nitrière de Tacunga, dans l'Etat de l'Equateur."

Metallurgy.

Although there are several patent processes, of more or less merit, which may eventually require a notice from us, these are all

* 'Kong. Vet. Acad. Handl.' 1823, p. 184.
† 'Neues Jahrbuch für Mineralogie,' 1 Heft, p. 45.
‡ Ibid., 2 Heft, p. 181. § Ibid., p. 227. ‖ Ibid.
¶ 'Journal für Praktische Chemie,' No. 1, p. 60.
** Ibid., No. 2, p. 125. †† Ibid., No. 3, p. 180.
‡‡ 'Oesterreiche Zeitschrift für Berg. und Hüttenwesen,' p. 102.
§§ 'Berg. und Hutten männische Zeitung.'
‖‖ 'Comptes Rendus,' No. 5, p. 200; No. 8, p. 369; No. 12, p. 660.
¶¶ 'Annales de Chemie et Physique,' Mars, p. 358.

at present in the condition of undeveloped schemes. Beyond those, there is an entire absence of any real improvement in any branch of metallurgy to be noticed.

M. L. Cailletez has an interesting memoir on the "Dissociation des gaz dans les foyers métallurgiques," in which he confirms the results obtained by M. H. St. Claire-Deville by experiments on a laboratory scale.*

IX. PHYSICS.

LIGHT.—Father Secchi has sent to the Academy of Sciences an account of the spectra of some stars, as recently seen by him in a new spectrometer by Merz, with a prism by Hofmann, of Paris. A drawing of the spectrum of α Orionis accompanied the communication. The spectrum of Sirius is described by the learned author as resembling that of sulphur.

A suggestion, which is likely to be of considerable value to photographers, has been made by Dr. Angus Smith, F.R.S. The cause of the destruction of photographs, apparently by the action of time only, is generally considered to be due in reality to the presence of a minute quantity of hyposulphite of soda remaining in the paper. Hitherto almost the only plan of getting rid of this agent has been long and continuous washing in cold or hot water. Dr. Angus Smith has suggested oxidizing the hyposulphite of soda into sulphate of soda (which is likely to be harmless), by means of dilute peroxide of hydrogen. Peroxide of hydrogen has been little known to chemists, and even now it is seldom obtained in its pure state. It is, however, to be had in a solution, and in a state sufficiently strong for many important purposes in analysis. Oxides, such as in the case of manganese, which will not fall till more highly oxidized, are with advantage treated by it. The lower oxide may remain unobserved in a solution, and in a state of minuteness sufficient to keep it in suspension; but at the moment of contact with the peroxide of hydrogen it blackens and falls.

When the peroxide is poured into a solution of hyposulphite of soda, the change is not observed, as there is no coloured oxide to be formed; but when a salt of barium is afterwards added, it is found that sulphuric acid has taken the place of hyposulphurous. The strength of the solution does not require to be great. That which is sold contains about nine volumes of available oxygen. If diluted a thousand times, a solution is obtained capable of oxidizing hyposulphites. It appears that all the hyposulphurous acid is instantly converted.

Peroxide of hydrogen is in reality an oxide of water; when the

* 'Les Mondes,' April 19, 1866.

oxygen leaves it to do its work nothing but water is left; nothing being added to be washed out.

The peroxide, as sold, contains a little acid (sulphuric); when made alkaline it does not keep so well. If a drop is put upon a photograph it very slowly bleaches; its use in this undiluted state is not recommended. Again, if the peroxide, as sold, is neutralized, the bleaching does not take place, at least in an hour, an ample time. For neutralization soda may be used.

HEAT.—M. Cailletet has continued the experiments of Deville on the dissociation of compound gases at high temperatures.

The author, by peculiar contrivances, drew air from blast furnaces, and submitted it to analysis. The first analysis is of gas taken from the hottest part of a furnace, and rapidly cooled by a stream of water, on the plan of M. St. Claire-Deville. The mixture was composed of—

	I.	II.
Oxygen	15·24	15·75
Hydrogen	1·80	"
Carbonic oxide	2·10	1·30
Carbonic acid	3·00	2·15
Nitrogen	77·86	80·80
	100·00	100·00

These results confirm those of Deville, and show that oxygen does not combine with hydrogen, carbon, or carbonic oxide at very high temperatures. The author afterwards took air from furnaces at lower temperatures, and the results show the gradual disappearance of the oxygen with the abasement of the temperature, and of course the increase of carbonic acid. M. Cailletet concludes that compound gases cannot exist at high temperatures.

A curious fact in relation to the storage of solar heat for future use has been communicated by M. Jeannel to the French Academy of Sciences. Fused acetate of soda, allowed to cool in the open air, crystallizes in prismatic needles at + 58°; allowed to cool, however, in a limited amount of moist air, it does not crystallize even at zero, but becomes a soft translucent mass. If, after having been so cooled, it is exposed freely to dry air, and touched with a dry solid body, it suddenly assumes the ordinary crystalline form of prismatic needles, and rises to the crystallizing point + 58°, or near it. M. Jeannel remarks that this experiment shows how solar heat may be stored up and made to re-appear again at will. It is possible, he says, in our climates to raise acetate of soda under bell-glasses or glass frames to + 59°. The acetate so exposed and cooled, sheltered from the air, does not crystallize, and is always ready to give out the heat again on being touched with a dry solid body.

M. de Vignette Lamotte has sent to the French Academy a long memoir, "On the Preservation of Wines by the Employment of Heat." M. Pasteur, reviving an old suggestion of Appert, proposes to heat wine for a few minutes to 70 or 80 C. The author objects to this, and says it is better to submit the wines for some time to a temperature not exceeding 45 C. He seems to admit, however, that Appert's or Pasteur's plan answers well with the more saccharine and alcoholic wines, like ports and sherries, &c.

Some remarkable results of the exposure of phosphorus to heat have been communicated by M. Hittorf to the 'Annalen der Physik und Chemie.' Schroetter states that red phosphorus returns to the state of ordinary phosphorus at 260° C., but M. Hittorf finds that this change does not take place under a temperature of about 447° C. At a lower temperature red phosphorus may volatilize, and its vapour acquire a high tension without ceasing to belong to the red modification. The transformation of ordinary into red phosphorus may easily be effected by heating in a closed vessel at a temperature above 300° C.

In vaporizing amorphous phosphorus, it does not melt; in this resembling its congener arsenic, which resemblance induced M. Hittorf to endeavour to crystallize this variety of phosphorus, which he believed would take rhomboidal forms like arsenic; his experiments proved him to be right.

Of the numerous attempts made by M. Hittorf, we will cite only that which was successful: it consists in heating red phosphorus and lead in a closed vessel, the lead dissolved the phosphorus, and then deposited it in a crystallized state. The operation was performed in a fusible green glass tube, a quarter filled with ordinary phosphorus, and the rest with lead; the tube was first cleared of air by means of a current of carbonic acid gas, then exhausted, and afterwards sealed. It was now introduced into an iron muffle, and the spaces filled with calcined magnesia, pressed round the whole of the glass tube.

After ten hours' heating, the lead was covered with brilliant flakes of metallic-looking phosphorus, the finest appearing red when held to the light.

No polyhedric form could be recognized in these crystals, but the lead retained some. These were isolated by treating by nitric acid of 1·1, which has no action on phosphorus, while it readily forms nitrate of lead.

The crystalline powder accumulated at the bottom of the vessel was "metallic" phosphorus, which was then in the form of a mass of microscopic rhombohedra, resembling crystals of arsenic. In this state phosphorus is a conductor of electricity; at 15·5° C. its density is 2·34.

M. Hittorf classes the new modification of phosphorus in the same category with red phosphorus, and gives to the two the generic name of metallic phosphorus, which he subdivides into metallic crystallized and metallic amorphous. Commercial amorphous phosphorus is often in the crystalline state.

Microscopists and others who are occasionally engaged in the examination of organic tissues and gelatinous substances, will be glad to know of a method by which these bodies can be dried without the application of heat. A large number of substances, like gum, &c., have, as is well known, the property of agglomerating, upon drying, into amorphous masses, more or less solid and translucent, by which, on the one hand, the original appearance of the freshly made preparation is lost, and, on the other, complete desiccation rendered very difficult. In order to obviate this adhesion of the elementary particles occurring during the drying of such substances under ordinary circumstances, Reischauer has proposed to carry on this operation out of contact with the atmosphere, and by the aid of a suitable ethereal medium.

The apparatus employed for this purpose is, in its simplest form, a well-closed glass vessel filled with ether or a similar liquid, at the bottom of which is placed the chloride of calcium, quicklime, calcined sulphate of copper, &c., intended to absorb the water. A shallow vessel is placed below the surface of the liquid for the reception of the substance to be dried. The *modus operandi* is now a very simple one. The ether continually yielding its water to the chloride of calcium constantly withdraws it in turn from the substance to be dried, until, finally, the latter corresponds in its hygroscopic state with that of the desiccating agent. The thorough wetting in this manner of the constituent particles of the substance to be dried (which, of course, must be insoluble in an ethereal liquid) prevents their sticking together, and the original appearance is retained when dry.

Gum, separated by precipitating the aqueous solution with alcohol, gives an amorphous white mass of very slight adhesiveness, and with no trace of the common glass-like condition. The so-called diastase, or the body obtained by precipitating the extract of malt with alcohol, deprived of water under ether, forms spongy and very light granules. In this state it retains its effect upon starch. The microscopical examination of starch paste dried by this process leaves scarcely a doubt that the starch grains exist in paste in a state only of extraordinary expansion, and not in that of actual solution. Hops give a mass similar to diastase, but, however, no longer capable of producing fermentation. The organs of plants dry rapidly under this treatment, commonly retaining their colour, unless unusually delicate. Taken from the ether, they soon become moist again in the air, and rapidly lose their colour, which by a continuance in the liquid appears remarkably fine.

The behaviour of animal productions under this method of drying is of especial interest. It may be remarked, that generally, while vegetable matters are distinguished by their great brittleness in the dry state, those of animal origin are characterized by a remarkable toughness, which reaches its highest degree in the fibrous formations of the skin. The pliability of thick skin dried in ether over chloride of calcium is very extraordinary. Other animal preparations at the same time preserve their original form in the dry state, the usual contraction of the parts being thus avoided. The whole intestines of a young dog treated in this manner formed a remarkable anatomical preparation, in which the delicate structures were preserved in the most complete manner upon drying. The lungs and liver, to preserve which vain attempts have hitherto been made, formed a light spongy mass, retaining completely their organization. It is more than probable that anatomists can make use of this process in many cases; as, for instance, in the microscopical examination of the kidneys, pancreas, &c., particularly in those which have hitherto required the solidification of the object by chromic acid, &c. The use of the ether in a liquid form is frequently not necessary. The skin of animals, animal membrane, &c., readily assume in an atmosphere saturated with the vapour of ether containing a suitable strongly hygroscopic substance, a condition similar to that of white dressed leather. A like satisfactory result, however, is not obtained in the desiccation of inorganic substances, oxide of iron, alumina, &c., in artificial media. It is obvious that this process may be rendered useful under suitable modifications for other purposes. It is a ready method, according to Reischauer, for removing acid bodies soluble in ether from their aqueous solutions, by putting them into an ethereal liquid with caustic lime or potassa.

In chemical research it is frequently desirable to have the means of producing a very low temperature; but owing to the trouble and delay in preparing a freezing mixture, it is seldom employed. Mr. Crookes has described a plan by which a very low temperature is produced, by forcibly blowing a mixture of air and volatile liquid through a fine jet.

The instrument is the well-known one made by Messrs. Krohne Sesemann, for the purpose of producing local anæsthesia in surgical operations, and the liquid recommended to be used is perfectly pure ether. Two ounces of liquid were put into the four-ounce bottle belonging to the instrument; the air was forced in by means of a small india-rubber hand-pump, and the jet was about the size of that of an ordinary mouth blowpipe. By means of small wires the inner orifice of the jet could be contracted at pleasure.

When the liquid used was ordinary ether from methylated spirit, and the distance of the bulb of the thermometer from the jet $\frac{1}{2}$ inch the lowest temperature was – 20°·7 C., and the bulb of the thermometer became quickly coated with ice, condensed from the atmosphere. Water in a test-tube held in front of the jet commenced to freeze immediately. With pure ether, sp. gr. ·720 C., prepared expressly for anæsthetic purposes, a temperature of – 21°·6 C. was produced, and a considerable quantity of ice condensed round the bulb of the thermometer, so as to impede the cooling, unless occasionally removed. Absolute alcohol gave a temperature of + 8°·0 C. Pure methyl alcohol, sp. gr. ·803, + 1·1 C. Solution of ammonia, sp. gr. ·880, – 11·C. Chloroform, – 5·1 C. Bichloride of carbon, – 2·2 C. Bisulphide of carbon gave a temperature of – 17·6 C.; large quantities of ice condensed on the bulb, coating it nearly ¼ in. thick. In a few minutes the bisulphide of carbon ceased to issue regularly from the jet, and miniature snow-balls were blown out at intervals. The bisulphide of carbon apparently contained water. The temperature of the room was 18°· C.

Most of our readers are acquainted with the ingenious apparatus of M. Carré for the production of a low temperature by means of ammoniacal gas. M. Knab has proposed a new process for its condensation. Chloride of calcium absorbs its own weight of ammoniacal gas, which is again evolved on the application of heat. The chloride will serve an indefinite time. M. Knab considers that his discovery will be found very useful: 1, Because chloride of calcium saturated with ammonia is a dry powder easy of transport; 2, because chloride of calcium is of very little value; and 3, while water will only hold in solution 20 per cent. of ammonia, the chloride will hold 50 per cent., so that the cost of sending ammonia about will be greatly diminished.

Electricity.—M. E. Becquerel has presented to the French Academy a memoir "On the Thermo-electric Powers of Bodies, and on Thermo-electric Piles." In his last memoir the author stated that bars of sulphide of copper obtained by fusion were very differently endowed with electro-motive energy. He now publishes his discovery that all these bars may be made to exhibit an equal power by simply subjecting them, after fusion, to a dull-red heat for several hours. The second part of the memoir is devoted to an account of the electro-motive force of various alloys, in which he shows that an alloy of equal equivalents of cadmium and antimony may advantageously replace tellurium in the construction of piles for the study of calorific radiation.

M. Gerardin has described a *battery of iron turnings.* The zinc of a Bunsen's battery is replaced by iron borings. The iron is placed in common water. The porous vessel contains a solution of perchloride of iron in *aqua regia.* The positive pole is made of powdered coke agglomerated with paraffine. Such a battery may be made of large dimensions, and a great deal of electricity obtained at small cost.

M. Torreggiani has also described *a new battery* and a practical application of it. After repeated experiments, he has proved that a pile in which the positive pole is represented by metallic lead, and the negative by carbon, and containing a saline solution (an alkaline acetate), gives, besides electricity, a large quantity of pure carbonate of lead, which may be profitably employed. The author considers that this is an easy and innocuous way of making white lead.

All discoveries in electricity which have been made for many years have been surpassed in practical importance by one, the particulars of which were communicated to the Royal Society a few weeks ago by H. Wilde, Esq. Space will not permit of our giving more than a brief account of this invention; but in our next issue, we propose to lay before our readers a full account of his entirely new magneto-electric machine. The principle is not difficult to understand. An armature wound round with insulated wire is made to revolve rapidly in front of the poles of a large permanent magnet. The currents of electricity thus induced in the insulated wire are carried round a large electro-magnet, which is thereby excited to a very high degree. In front of this electro-magnet a second covered armature is rotated, and the electric current thus generated is carried round a third electro-magnet. It is from a rotating armature in front of this third magnet that the electric current ultimately used for heating or lighting effects is produced. At each passage round the electro-magnets, and induction in the rotating armatures, the electric current becomes magnified to an extraordinary degree, until ultimately it is powerful enough to melt iron bars in a minute or two, and to produce a light surpassing that of the sun itself.

The machine is driven by means of a steam-engine, and as almost the only current expense is for motive power, it is not an improbable supposition that ere long electric lights of the most intense description will be as common in large factories and public buildings as gaslights are at the present time.

X. ZOOLOGY AND ANIMAL PHYSIOLOGY.

(*Including the Proceedings of the Zoological Society.*)

Ethnology or Anthropology is one of those studies which are as yet in a very infantile condition, and those who pursue it have to content themselves with the accumulation of facts, waiting the time when their material may justify the establishment of those broad generalizations which constitute the foundations of a true science. Mr. Mackintosh has lately published some remarks on the "Comparative Anthropology of England and Wales,"* which in their disconnected character well exhibit the want of some systematic principles to connect the observations of the practical ethnologist. The paper is illustrated by a plate containing portraits of some twenty-eight individuals, male and female, from various parts of England and Wales; and it is from the study of physiognomy and habit that the author has attempted to draw some conclusions as to the sources of the population of our country. He remarks on the character and appearance of the inhabitants of various localities, and from his observations draws conclusions as to the races inhabiting different counties, much in accordance with those of previous observers. At the same time, it may be remarked that the evidence submitted—namely, a selected series of twenty-eight portraits—is hardly satisfactory with regard to the facial characters of such a various and mixed population as that of England and Wales. It is hardly a safe thing to theorize upon the similarity between the countenances of Professor Steenstrup and the inhabitants of the north and east of England; nor can Sir Bulwer Lytton's novels be accepted as works of authority in ethnology. A very detailed examination and very careful illustration will be necessary in order to establish many of the bare assertions and hypotheses contained in this pamphlet; it may, nevertheless, be valuable as indicating a direction in which research may be extended.

Mr. Luke Burke, the editor of the 'Ethnological Journal,' is at the present time publishing in his pages a series of articles on the "Principles of Ethnology," and it is much to be hoped that he may succeed in laying some solid foundations on which the Science may rest.

In the 'Bulletins of the Anthropological Society' of Paris last issued, is an interesting paper, by M. Paul Broca, "On the Seat of the Faculty of Articulate Language." He endeavours to show that the faculty of speech is specially subject to the third convolution of the frontal region of the cerebrum, and brings forward several cases of injury or natural deficiency in this part to support his view. It appears, however, that in the great majority of cases the left hemisphere of the brain was alone affected, whilst injury to the right hemisphere produced no effect. M. Broca explains this by reminding us that nearly every person is right-handed, and that consequently the left side of the brain has to take the lead in nearly all voluntary actions; moreover, Gratiolet has observed that the convolutions of the left hemisphere are developed at an earlier period than those of the right. Hence, M. Broca argues that it is the left-third frontal convolution which is pre-eminent in the faculty

* 'Anthropological Review,' January, 1866.

of speech, and that though when this is injured, by long trial the right side may be made to do its work, yet in the normal state the right side takes no very active part. He compares the case to the attempt to use the left hand for writing, when the right hand, which has been trained to work with facility, has been injured. M. Broca's argument is certainly ingenious, and will doubtless give phrenologists some hope of yet mapping out the convolutions of the brain to their respective "faculties."

The Sphygmograph, which is exciting some attention just now, is one of those ingenious instruments which have been devised of late years, promising really to assist medical men in reducing their art to something like a science. Its great merit is this, that it gives a permanent and minutely accurate record of a phenomenon which before was known only by the very unsatisfactory discrimination of the sense of touch.*

The sphygmograph is an instrument for producing a self-written record of the swellings and contractions of the arteries known as the pulse. Its inventor, Dr. E. J. Marey, is a Paris physician, who is well known for many valuable physiological essays. The main features presented by the instrument are the following:—A principal beam of light construction is fastened on the arm by carefully padded straps; to this is attached a lever of nearly the length of the fore-arm; the shorter arm of this lever rests gently but firmly on the pulse; at each rise of the artery and subsequent fall the motion is exactly imparted to the lever, and the end of the longer arm performs the same movements as does the shorter, but on a much larger scale. To the end of the longer arm is attached a fine-pointed pencil, in contact with which a smooth strip of paper is made to move by clockwork in a horizontal direction. The effect of this arrangement is, that a straight line would be drawn on the piece of paper were it not for the rhythmic perpendicular movement caused by the pulse, which results in the production of an undulated line, the waves in which represent the separate expansions of the artery; of course, it is evident that since the movement of the paper is invariably uniform, the variations in the pulse will be distinctly indicated by the height, length, and form of the waves; and accordingly we have a most accurate and valuable means of comparing the pulse in various individuals and under various circumstances. Some interesting results have been obtained by studying the pulses of diseased persons, and the instrument has been found to exhibit phenomena in the pulse which it was quite impossible to detect by the rough-and-ready means of the fingers. The "sphygmogram" of a person afflicted with a certain disease of the heart, for example, is found to exhibit a series of undulations, the ascending line of which is

* 'On the Use of the Sphygmograph in the Investigation of Disease.' By Balthazar W. Foster, M.D., M.R.C.P. Lond., Professor of Clinical Medicine in Queen's College, Birmingham. 30 pp. Crown 8vo.

very long and tremulous, and but slightly oblique, while the descending is abrupt and nearly perpendicular. The application and value of the instrument will be apparent from these remarks.

Dr. Edward Schunck has communicated a paper to the Royal Society "On the Colouring and Extractive Matters of Urine." He is led by his experiments to conclude that human urine contains at least two peculiar colouring matters,—one soluble in alcohol and ether, while the other is soluble in alcohol but not in ether. The existence of a third insoluble extractive matter appears very doubtful.

In our last "Chronicle" we noticed the researches of M. E. Alix, on the "Parturition of the Marsupials," in which he attributed the discovery of the mode of performance of this function to M. Jules Verreaux, and also on anatomical grounds supported Sir Everard Home's views in opposition to those of Cuvier and Owen. Prof. Owen has now sent a communication to the Academy of Sciences of Paris, in which he overthrows the claims of M. Alix to a discovery, and at the same time reviews his own labours on the question at issue, and gives an account of the parturition of a *Macropus major*, which he had isolated at the Zoological Society's Gardens for some time, several years since. It appears that M. Alix had only consulted Prof. Owen's researches through the medium of a Cyclopædia.

Dr. Drosier, of Caius College, Cambridge, has lately been making some observations on the Functions of the Air-cells and the Mechanism of Respiration in Birds. He remarks that several of the commonly received views are quite untenable, such as that the air-cells are intended to assist in supporting the bird in flight by rendering it lighter, in consequence of the rarefaction of the air in the air-cells and the hollow bones; and again, that the air-cells are a sort of second respiratory apparatus, so that birds may be described, as they were by Cuvier, as animals having a double respiration. In disproof of these views, Dr. Drosier has shown that a pigeon weighing ten ounces would have its weight in air diminished by less than one grain, in consequence of the rarefaction of the air in its air-sacs and hollow bones; so that the floating-power resulting from such rarefaction would be almost inappreciable. Again, the air-cells are so sparsely supplied with vessels, that they can offer but very little blood for oxidation. It has been frequently supposed that air passes from the air-sacs into the cavities of the peritoneum and pericardium, and even between the muscles. This is, however, an error, as was shown by Guillot and Sappey. Dr. Drosier conceives that the air-sacs are simply appendages to the lungs for the reception of air. The respiration of birds is necessarily very rapid and vigorous, and at the same time the lungs are small. The large quantity of air inhaled at a respiration is received into the air-sacs, and by the alternate contraction and expansion of the

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thoracic and abdominal cells, a continuous stream of air is made to play upon the naked capillaries of the lungs. The hollow bones Dr. Drosier believes are filled with air not for respiratory purposes, but to remove the moisture from the interior of the bones, which would otherwise accumulate and render them heavy. Dr. Drosier is intending to extend his researches and publish them in a volume.

Mr. Harry Seeley has lately published an article in the 'Annals and Magazine of Natural History,' entitled "An Epitome of the Evidence that Pterodactyles are not Reptiles, but a new Sub-class of Vertebrate Animals allied to Birds (*Saurornia*)." Mr. Seeley is a clever and persevering osteologist, and has been for many years working at the Pterodactyles, which are so numerous in the Cambridge Greensand deposits. He has in this paper succeeded in showing that the affinities between Pterodactyles and Reptiles are very little stronger than those between Pterodactyles and Birds; in fact, that though these flying lizards resemble birds and reptiles more than they do any other vertebrates, yet the resemblance is very small, and hence he separates them as a distinct group, *Saurornia*. It is, nevertheless, quite a question for consideration whether Pterodactyles depart more from the exceedingly plastic Reptilian type than do the Chelonians or Ophidians, or than do the Bat and Whale from the Mammalian type. It must be borne in mind that while Birds, of all Vertebrata, are the most fixed and uniform in their general structural form, Reptiles are among the least so; and hence it is no such astounding anomaly to discover a winged lizard, while the occurrence of a lizard-like bird might be deemed improbable.

M. Victor Fatio has been writing on the various modes of Coloration of Feathers. The question of changes of plumage has presented itself in various ways. Is a new coloration always the peculiarity of a new feather? or may the coloration sometimes undergo alteration in the same tissues? It is very certain that when a feather has once grown, its colour cannot be affected by nutrition, inasmuch as all communication between it and the blood-vessels is at an end—the pulp having dried up. M. Fatio therefore attributes the alteration in the colour of completely-grown feathers to the humidity of the air, temperature, light, movements, and the grease of the bird. The modifications produced by these agents are the various development of certain parts, the solution and diffusion of the internal pigment and the rupture of the external parts.

M. Gerbe has communicated some important papers lately to the French Academy on the larvæ of marine Crustacea. With regard to his observations on the vascular and nervous systems, there has been some little contention, since M. Milne-Edwards has inserted a note in the 'Comptes Rendus,' stating that he has much satisfaction in finding that M. Gerbe's results accord entirely with his own, published more than thirty years since. MM. Coste and Blanchard, however, defend the value of this part of M. Gerbe's work. It appears that no one had previously studied the *Phyllosoma*, and that the earlier observations had reference to a branchiferous disposition of the vascular system, while M. Gerbe has carefully described the vascular apparatus in these abranchiate Phyllosomatous larvæ of Decapods. In his last note published, M. Gerbe gives the following among the conclusions to be drawn from his researches. It is not until the fifth or sixth moult which follows birth that the general form of the adult can be detected in the larvæ of Podophthalmatous and Edriophthalmatous Crustacea, and it is to these transitory forms, so different from those of the perfect animals, that a crowd of false species, of false genera, of doubtful families belong, and even, in the case of *Phyllosoma*, an entire order which is spurious. With the exception of the lobsters, the larvæ of all genera are when born destitute of any branchial apparatus, and hence their respiration being tegumentary, the circulation is necessarily very different from what it afterwards becomes. None of the larvæ ever present even rudimentary reproductive organs.

The development and reproduction of the Nematode worms is a subject which has lately been receiving considerable attention. Professor Leuckart has been most successful in tracing the modifications of several forms. Herr Mecznikow, who has been working in Professor Leuckart's laboratory, discovered that *Ascaris nigrovenosa,* which inhabits the lung of the brown frog, produces larvæ which enjoy a free existence, *in which they attain to a sexual development.* This very remarkable discovery has been exciting some contention, inasmuch as both Professor Leuckart and his pupil are anxious to receive credit for it. The larvæ which exhibit this curious phenomenon differ considerably from their parents; their development was traced by keeping them in a watch-glass with moist earth, and a part of the contents of the rectum of the frog. By this manipulation many forms of Nematodes may be kept for study and observation, which would perish when kept in pure water only. Professor Leuckart has carefully watched the development of the embryos produced by ova from the female larvæ, duly impregnated by the males, and has traced them into the perfect *Ascaris nigrovenosa* in the frog's lung, and has found that they are all invariably females, so that there can be no doubt that the production of young in the parasitic *Ascaris* is entirely parthenogenetic. It is beyond doubt also, he says, that this mode of parthenogenesis is widely diffused among the Nematodes, and cites as a tolerably certain instance of it the case of *Filaria medinensis.* With respect to this species, it seems probable from Carter's observations that, as in *A. nigrovenosa,* there are two kinds of generations, a parasitic and a free, and if so, we should have an exact analogy with the parasite of the frog's lung.

Max Schultze's 'Archiv fur Mikroskopische Anatomie' is a journal which has been started by the Professor at Bonn, and has already attained to its fifth number. It contains many very valuable papers. Amongst others there have been three on various matters relating to those strange little creatures, the *Tardigrada*, or "bear-beasties," as the German name for them may be translated. Dr. Richard Greef contributed a paper on their nervous system to the first number, as also another in the last issue, relating to the genus Macrobiotus, both of which are excellently illustrated. A paper "On the Movements of the Diatomaceæ," by Prof. Schultze, in the fourth number, is one of great interest—it is the author's opinion that a sarcodic organic substance is spread over the whole external surface of the Diatom which is the chief agent in rapid movement. He does not, however, consider that this affects the question of the animal or plant-nature of Diatoms. The papers in this journal which are devoted to the mechanical wants of microscopists will be found very good. There are many useful and important pieces of apparatus described in its pages which English makers would do well to introduce for us into this country.

A paper, by Professor Leydig, of Tübingen, "On *Phreoryctes Menkeanus*, Hofm.," appears in the third part of this journal, and is well worthy of attention. This extraordinary worm was originally discovered by Herr Menke in a brook at Pyrmont, and it was first described by Hofmeister as *Haplotaxis Menkeana*, which name was afterwards changed to its present appellation. For a long time the only known habitat was the original site in which the worm was discovered, but it has since been met with by Leydig at Tübingen, and it is stated by Leuckart to be common at Giessen, so that we may hope to hear of its occurrence in this country. A second species, apparently belonging to the same genus, was described by Schlotthauber in 1859. The worm, which strongly resembles a Gordius, has a cylindrical body, about half a line thick and more than a foot long. When viewed alive, it is at once seen to present all the characters of a true Annelid. There are four rows of setæ on the sides and ventral aspect, each segment presenting on either side a larger seta, which is placed quite on the ventral aspect, as in the common earth worm, and a smaller one, which from its position might almost be termed dorsal. In the middle portion of the body the ventral setæ sometimes occur in pairs on either side, but more usually only one is met with. The setæ themselves have a slight sigmoid flexure, with a small enlargement in the middle. According to Schlotthauber, the proper habitat of the worm is moist earth; but according to Leydig's observations it would seem to be truly aquatic, or, at any rate, to require exceedingly wet mud for its abode.

Zoological Society of London.

Mr. St. George Mivart has, during the past quarter, communicated two memoirs to the Society, on the Anatomy of Quadrumana —a subject in which he has already been working for some time. One is on the dentition, and other points of structure, in the rare Lemurine animal *Microrhynchus laniger*, of Madagascar; the other is a joint paper with Dr. Murie (the prosector to the Society), "On the Anatomy of the *Lemuroidea*," principally relating to the myology of these animals.

The appointment of a prosector, and the building of a well-arranged dissecting-room in the Society's gardens, have, no doubt, done much to assist the study of comparative anatomy. Besides the above papers we have, as a result of this liberal movement, during the past quarter, an excellent paper by Dr. Murie and Mr. St. George Mivart, "On the Anatomy of the Agouti (*Dasyprocta cristata*)," principally in reference to the myology of this animal.

Among the papers relating to descriptive zoology are descriptions of three new monkeys, by Dr. Gray, *Cercopithecus erythrogaster*, living in the menagerie; *Nasua dorsalis*, from South America; and *Macacus inornatus*, also living in the gardens.

The Society has also lately obtained for its menagerie a rare monkey from Demerara, *Pithecia leucocephala*. Dr. Gray has also described a new Porcupine (*Acanthion Grotei*), specimens of which are in the Gardens and also in the British Museum; also a new Bat from Angola (*Scotophilus Welwilchii*), and a new Bush-bock (*Cephalophus breviceps*), as well as various mammals recently received from Port Albany, North Australia, amongst which were several species new to science.

A large number of new and rare birds have also been noticed and described at the meetings of the Society by Mr. Sclater, Mr. Gould, Dr. Hartlaub, and others. Mr. Tegetmeier exhibited a drawing of the Dodo (*Didus ineptus*), supposed to be an original one, from which it appeared that the plumage of this remarkable bird was white. Mr. Sclater and Mr. Salvin have laid before the Society a catalogue of the birds collected by Mr. Edward Bartlett during his recent expedition up the river Ucayali, in Eastern Peru, with notes and descriptions of the new species. The total number of specimens contained in Mr. Bartlett's collection was about 700, referable to 252 different species, of which twelve proved to be new to science.

Some valuable communications on Lepidoptera have been presented to the Society by Mr. A. G. Butler; and Mr. Flower at one meeting exhibited some insects captured in the Atlantic on board the ship 'Hotspur,' about 300 miles from land.

Amongst Mollusca, a list of species collected in Formosa, by Mr. Swinhoe, was furnished by Mr. H. Adams.

THE INTERNATIONAL HORTICULTURAL EXHIBITION AND BOTANICAL CONGRESS.

This grand meeting of English and foreign Botanists and Horticulturists, so long expected, took place on the 22nd of May, at South Kensington. This meeting is only one of a series, the first of which was held at Brussels in 1864, the next at Amsterdam in 1865, this year, 1866, in London; in 1867 the Congress meets in Paris, and in 1868 at St. Petersburg. It is expected that the country where the Exhibition and Congress is held, will endeavour to give as complete a representation as possible of its own Botany and Horticulture. Hence, in the late Horticultural and Botanical display at South Kensington, our great nurserymen and botanists were legitimately masters of the position. And well did they maintain our national pre-eminence in Horticulture! Never was there a larger or a better flower-show exhibited on English soil.

The general plan consisted of a rectangular plot of ground, 560 feet long by 300 feet broad, covered throughout by 40,000 yards of canvas, forming a vast pavilion or tent, overspreading about 3½ acres. The ground thus enclosed and covered was laid out as an ornamental garden, with broad and winding gravel walks, grass-terraced banks, waterfalls, artificial lakes, hills and valleys, and rockeries, the object of the whole arrangement being to display the plants to the best advantage, and give the visitors every facility for seeing them.

The view on entering the tent was truly beautiful and pleasing, reflecting much credit on the taste and judgment of the gentlemen of the Executive Committee, who devised the plan, and by whom all the arrangements were effected, *viz.* Mr. Gibson, Mr. Eyles, Dr. Masters, Mr. T. Moore, and Dr. Hogg. From the raised ground at the southern end, a very fine and comprehensive *coup-d'œil* was obtained of an undulating landscape of flowers, shrubbery, and trees, every zone and climate under heaven having apparently been ransacked of its botanical treasures to furnish the brilliant and imposing scene. A valley of Rhododendrons sloping down to the banks of an artificial lake!—masses of bloom grouped on every eminence and covering the green shelving banks, magnificent Azaleas and Pelargoniums in full dress, their stems and flowers tied to rings and hoops like a lady's crinoline—certainly a method of perverting the natural growth of the plant, which will be one day abandoned—Calceolarias and Cape Ericas in astonishing perfection, Roses of every hue, and Coniferous evergreens,—here and there a tall and noble tree-fern (*Cyathea medullaris*), towering aloft with its gracefully drooping fronds, Bananas, Palms, Dracænas, Pandani, Cycadaceæ, and other tropical evergreens—the whole scene was one from fairy-land.

It was, however, in the Orchid tent that the main horticultural attractions were centred. This department, separated from the rest of the pavilion by a canvas screen, 500 feet in length and 40 feet in width, was heated throughout by iron pipes, furnished gratuitously by Mr. Henry Ormson, the horticultural engineer. A broad, central, gravel walk, with sloping grass-covered terraced banks on either side, traversed its entire extent. On the eastern side the chief attractions were variegated-leaved plants, Caladiums, Marantas, Begonias, Lycopodiaceæ, Cypripediums, Japan Lilies, and ferns; on the western side, a space of about 400 feet of the bank was allotted to the Orchids, some of them of the very rarest kinds and of almost fabulous value. These gorgeous epiphytes of the tropical forest, which take the place of moss and lichen on the stems of the trees of the temperate zones, were here exhibited in all their beauty and fragrance, Vandas, Cattleyas, Dendrobiums, Onycidiums, Epidendrons, Odontoglossa, and Phalænopsis being the most conspicuous genera. We noticed also, on the same bank, the beautiful *Cypripedium barbatum*, and very fine samples of the *Sarracenia purpurea*, or North American pitcher-plant Beneath the bank of Orchids, on the same side of the tent, there was an interesting collection of economical and medicinal plants exhibited by Mr. Linden, of Brussels, including the tea, coffee, and cocoa shrubs, the spice plants, gamboge, mahogany, lignum vitæ, nux-vomica, gutta percha (*Isonandra guttata*), and India-rubber trees (*Ficus elastica*); and at the southern end of the tent were to be seen some most superb specimens of the pitcher-plant of the East Indies (*Nepenthes*).

Amongst the vegetable rarities on exhibition we noticed the *Ouvirandra fenestralis*, or lattice-plant of Madagascar; the *Raphanus caudatus*, or rat-tailed radish, first introduced into England from India by Mr. Bull. It is a straggling plant, about two feet in height, with Cruciferous flowers, and slender drooping pods which form the esculent portion or radish. Although the seeds of this plant when first introduced sold at the rate of eight for a guinea, yet as it thrives well in this country, it will probably soon become one of our commonest esculents. The *Lilium auratum*, the first bulb of which cost Messrs. Veitch 1,200 guineas, and Mr. Linden's exquisitely delicate white flower, the *Psychotria nivosa*, attracted universal admiration. There were also some very lovely specimens of Anæctochilus.

A box of 50 Alpine and herbaceous plants exhibited by Mr. James Backhouse, of York, not at all showy in appearance, nevertheless attracted considerable attention on account of the variety and rarity of its contents. We noticed in this box the North American *Cypripedium acaule* and *Dodecatheon integrifolum*, *Ranunculus glacialis* which flowers amidst the melting snows of the Alps, the *Myosotis montana* or mountain forget-me-not, which forms a dense little bush of large clear blue flowers, *Gentiana acaulis* showing as in its mountain home its large deep-blue flowers, the scarlet-flowered *Anemone fulgens*, and several other Alpine beauties, familiar to the tourist, forming altogether a most interesting collection, reminding, doubtless, some of the visitors of Chamouni, the Grindelwald, and the mountains of Switzerland, with their robes of eternal snow.

To attempt to enumerate all the rare and beautiful plants beneath the covering of that capacious tent is indeed a hopeless task. Messrs. Veitch alone had about 10,000*l*. worth of plants on exhibition, and 30,000*l*. would not have purchased the collection of Orchids. Some idea of the immensity of the collection may be gathered from the lament of a well-known Hammersmith horticulturist, that he could scarcely find his name in the garden although he had sent down twenty wagon-loads of plants and trees!

Prof. De Candolle, the President of the Botanical Congress, together with some of its most eminent foreign members, were presented to the Prince and Princess of Wales, who, accompanied by Prince Alfred, the Princess Helena, the Princess Mary of Cambridge, the Duke and Duchess of Cambridge, and Prince Teck, honoured the opening day with their presence.

Amongst the numerous foreign contributors to this truly international display, who must have been at considerable expense in the importation of their plants, the collections of Mr. Linden, of

Brussels, and Mr. Verschaffelt, of Ghent, stood pre-eminent. But to both English and foreign horticulturists, the public owes hearty thanks for a sight of so many rare and beautiful plants. When it is remembered that cultivators prize such plants quite as much as artists prize choice and beautiful pictures, the expense connected with their culture and transportation, and that they must necessarily suffer more than works of art, when shown to great crowds, by the conditions to which they are exposed, the noble emulation which could forget all personal and selfish considerations, and prompt to their exhibition on a rare occasion like the present, will be understood and acknowledged. The public indeed appeared thoroughly to appreciate this floral display, so that instead of four days the Council decided that it should be kept open for nine days.

On the evening of the opening day a banquet was held in Guildhall, the Lord Mayor presiding, to which 100 distinguished foreigners were invited as guests.

After the usual loyal toasts had been duly honoured, Sir Wentworth Dilke proposed the health of the foreign visitors, and especially Professor De Candolle, the President of the Botanical Congress. Professor De Candolle returned thanks in the French language. He said the unhappy state of things on the Continent had prevented many foreign botanists and horticulturists from coming. "What science wants above all is liberty, not only political liberty, which is to a certain extent very necessary; but, above all, that liberty which is accorded to the individual by public opinion. Those who seek for scientific truth require to be protected by the public, even more than by a free political system. Science prospers when allowed this freedom, and then neither revolutions nor war can stop its onward progress."

The Botanical Congress held its first session on the 23rd of May, in the Raphael Cartoon Rooms, in the South Kensington Museum. It consisted of about 130 representatives from foreign countries—France, Belgium, Holland, Germany, Russia, Italy, Switzerland, Portugal, and America being each represented in the Congress by one or more members; Professor Alphonse De Candolle, from Geneva, presiding. After the introductory address, which was delivered in the French language by the president, papers were read by the various botanists, British and foreign, in their own language, discussions occasionally following the reading of the paper. On the 24th, the Congress held at the same hour its second and final session. The attendance each time was large and brilliant, many ladies being present. These two meetings will long be remembered as a happy and instructive holiday by those who were so fortunate as to take part in them. Many were the personal acquaintances made there for the first time, by horticulturists and botanists, who had previously only known each other by name and reputation. Nearly fifty papers in English, French, German, and Italian were sent in to the Congress, the principal topics discussed in these papers being the practice of horticulture, vegetable morphology and physiology, structural botany, the geographical diffusion of plants, and their classification. The company assembled included M. De Candolle of Geneva, Professor Koch of Berlin, M. Reichenbach of Hamburg, M. Lecoq of Clermont Ferrand, M. Caspary of Konigsberg, M. Weddell of Poitiers, M. Meissner of Basle, Professor Morren of Liege, M. Schulz Bipontinus of Deidesheim, M. Van Houtte of Ghent, M. Linden of Brussels, Verschaffelt of Ghent, Van Heuzck of Antwerp, Wendland of Hanover, Triana of New Granada, and the principal British botanists: Bennett and Gray, of the British Museum; Berkeley, Bentley, Hogg, Masters, Howard, and Ward, of London; Dr. Daubeny, of Oxford; Dr. Moore, of Dublin; and Dr. Dickson, of Edinburgh.

In opening the Congress, the president, Professor De Candolle, said:—"Before I commence my address in French, allow me to say a few words in English: first, as a mark of respect to this great country, and next in explanation of my views for the conduct of the present and future meetings of this kind. We have to choose between two alternatives, either that every member should speak in his own language, or in that of the country where the Congress meets. This last method would destroy the equality between members which is desirable in every public assembly, not a few would be reduced to silence, or, at least, prevented from taking part in the discussions, and several distinguished men would, therefore, avoid international congresses. The other plan, of letting every one speak in his own language, appears to be much more convenient. For these reasons I shall address you in French, and in doing so I establish, in fact, the right of every Englishman to speak in English at Paris or at Berlin, at Florence or at Vienna, under similar circumstances."

Professor De Candolle then read his inaugural address. He commenced, by showing "the service that horticulture renders, or may render, to Botany. The most remarkable experiments of physiologists—*viz.* those of Hales, Duhamel, Knight, Gaertner, and M. Naudin—have been made in gardens. Horticulture has done much to advance the progress of physiological botany, but it has still much to do." M. De Candolle then suggested the construction of experimental green-houses and hot-houses, and gave his views as to the plan to be adopted in their erection, so as best to serve the purpose of the physiologist. "A building such as I propose, would allow of light being passed through coloured glasses or coloured solutions, and so prove the effect of the different visible or invisible rays which enter into the composition of sunlight. M. Von Martius placed some plants of *Amaranthus tricolor* for two months under glasses of various colours. Under the yellow glass the varied tint of the leaves was preserved. The red glass impeded the development of the leaves, and produced at the base of the limb, yellow instead of green; in the middle of the upper surface, yellow instead of reddish brown; and below, a red spot instead of purplish red. With the blue glasses, which allowed some green and yellow to pass, that which was red or yellow in the leaf had spread so that there remained only a green border or edge. Under the nearly pure violet glasses, the foliage became almost uniformly green. Now that plants with coloured foliage are becoming fashionable, it may interest horticulturists to know that by means of coloured glasses, provided they are not yellow, they may hope to obtain at least temporary effects as to the colouring of variegated foliage." "Nothing would be easier than to create in the experimental hot-house an atmosphere of carbonic acid gas, such as is supposed to have existed in the coal period. Then it might be seen to what extent our present vegetation would take an excess of carbon from the air, and if its general existence were inconvenienced by it. Then might be ascertained what tribes of plants could bear this condition, and what other families could not have existed, supposing the air had formerly had a very large proportion of carbonic acid gas." "Horticulture has a commercial tendency which may be carried too far. A horticulturist, who allows himself to be influenced by a scientific spirit, necessarily frees himself from over-selfish tendencies." The above extracts will show the spirit of this admirable address, and the enlarged and philosophical views with which it abounds. At the close of the reading a vote of thanks, proposed by Sir C. Wentworth Dilke M.P., and seconded by Sir Roderick Murchison, was carried by acclamation.

The following are some of the most important papers which were read at the two sessions of the Congress:—

Professor Caspary, of Konigsberg: "On the Change of the Direction of the Branches of Woody Plants." Professor Caspary has determined the following facts:—1. There is in winter a lateral movement of the branches of trees sometimes to the left, and also to the right-hand side, which movement is directly in proportion to the intensity of the frost. 2. The frost causes the branches of some trees to droop, and of others to rise, the extent of the downward and upward movement varying according to its mildness or severity. 3. In some instances the branches of trees exhibit both the above movements, rising when the frost is mild, and drooping when it becomes severe.

Mr. J. E. Howard, of London: "Observations on the Present State of our Knowledge of the Species of Cinchona." In this paper Mr. Howard mentions the fact of the great variability of the specific forms of this genus of plants. Every well-defined region of the Andes has its own prevalent and characteristic Cinchonas, which are incapable of being reduced to any one typical form. Mr. Howard believes that no species has been clearly proved to remain unchanged from end to end of the Cinchonaceous region. He has succeeded in obtaining, from a cultivated specimen of *Cinchona officinalis*, nearly as much quinine as from the bark of a plant of the same age grown abroad—probably the first time that quinine has ever been extracted from bark grown in Europe.

Mr. James Anderson, of Glasgow: "Observations on the Temperature of Water, and its Effects on Plant Cultivation." Mr. Anderson advocates the importance of employing water as warm as the air of the stove, or a little warmer, for watering tropical plants, especially orchids. Tropical plants so treated were invariably more vigorous and healthy. Those acquainted with Brazilian forests—the habitat of the Orchids—know that the rain-drops are always warm. This accounts for Mr. Anderson's success as a cultivator, and confirms the truth of his views.

Professor De Candolle, Geneva: "On a Recent very exact Measurement of the Diameter of the Trunk of one of the gigantic Sequoias of California." M. De Candolle exhibited a strip of paper reaching nearly across the room, and in explanation said that it was an exact measurement, recently made by M. De la Rue and an assistant, of the diameter of one of the gigantic trees of California—that known as the "Old Maid." The trunk of this tree had been broken off by a storm at a height of 128 feet, and its base now forms the floor of a dancing-room. M. De la Rue had measured it in the following manner:—A slip of paper was stretched across the diameter of the trunk, and the annual rings were marked off by a pencil on the paper. This paper he now exhibited. The number of rings was counted by M. De la Rue and his assistant, one counting from the circumference to the centre, and the other from the centre to the circumference; 1,223 rings were counted in the one case, and 1,245 in the other. The mean of the two observations, which was no doubt nearly correct, gave the age of the tree as 1,234 years. The diameter of the tree, at the height of about six English feet from the ground, was 26 feet 5 inches, and its entire height, before the upper part of the stem was broken off, was, approximately, 350 feet. The Sequoias grew very uniformly. The lines on the slip would show that at the age of 400 or 500 years the annual rings were still thick, while, in ordinary trees, the layers became thin at from 80—120 years. This demonstration excited the most lively interest in the Congress.

Very able and interesting papers were also read by Professor Karl Koch, of Berlin, "On Systematic Botany;" Dr. Moore, of Glasnevin, "On the Climate, Flora, and Crops of Ireland;" Professor Horren, of Liege, "On the Influence of Gaslight on Plants;" and Mr. W. G. Smith, of London, "On the Corona of Narcissus." The President then declared the Congress at an end; on which Mr. Bennett, of the British Museum, proposed, Dr. Daubeny, of Oxford, seconded, and Dr. Schultz Bipontinus, of Deidesheim, supported, a vote of thanks to the President, and the meeting separated.

The following are some of the papers forwarded to the committee; but as the time of the Congress was fully occupied with the reading of those already sent in, they were unavoidably excluded, but will probably be published at some future day.

Mr. W. Bull, Chelsea, "On the Relation of Horticulture and Botany to Mankind in general;" Mr. B. Clark, London, "On the Floral Envelopes of the Lauraceæ;" Dr. Masters, London, "Double Flowers;" Dr. Hildebrand, Bonn, "On the Necessity of Insect Agency in the Fertilization of *Corydalis cava;*" Mr. Tuffen West, London, "On the Structure of the Testa of the Seed of the Solanaceæ."

It is impossible to enumerate all the public and private entertainments given. Mr. Veitch gave a magnificent *déjeuner* at his exotic nurseries, Chelsea, to the foreign members and English botanists, before the formal business of the Congress commenced on Wednesday. The most distinguished of the foreign visitors were invited to their anniversary dinner, by the President and Council of the Linnæan Society. A large number were hospitably entertained at Kew, by Dr. Hooker. The *conversazione* at the South Kensington Museum was equally brilliant and successful with the exhibition, being crowded with visitors, foreign and English, distinguished by their rank or scientific position. Upwards of 500 gentlemen dined at St. Martin's Hall, under the presidency of Lord Henry Lennox. M. De Candolle and our foreign guests appear to have enjoyed themselves thoroughly, having been received with true English hospitality. When the most distinguished *savans* of different nations meet together to advance science, which has already conferred so many benefits on mankind, each expressing his thoughts in the Congress in his own language, may we not hope that national animosities and prejudices created for political purposes between nations will be counteracted, and that mankind will continue to advance in the knowledge and appreciation of those physical and moral truths so essential to their happiness, and which alone can form the basis of a permanent and enduring civilization?

Quarterly List of Publications received for Review.

1. A Dictionary; Geographical, Statistical, and Historical of the various Countries, Places, and Principal Natural Objects in the World. By J. R. McCulloch. New Edition, carefully revised by Frederick Martin. In Four Vols. Vol. I. *Longmans & Co.*

2. Notes on Epidemics, for the Use of the Public. By Francis Edmund Anstie, M.D. *Jackson, Walford, & Hodder.*

3. A System of Medicine. Edited by J. Russell Reynolds, M.D., F.R.C.P. Lond., Physician to University College Hospital and to the National Hospital for the Paralyzed and Epileptic. Vol. I. containing General Diseases. 960 pp. Demy 8vo. *Macmillan & Co.*

4. Rocks Classified and Described. A Treatise on Lithology. By Bernhard von Cotta. An English Edition, by Philip Henry Lawrence. Revised by the Author. 430 pp. Post 8vo. *Longmans & Co.*

5. A Treatise on Astronomy, for the Use of Colleges and Schools. By Hugh Godfray, M.A., Mathematical Lecturer at Pembroke College, Cambridge. 320 pp. Demy 8vo. With *Engravings on Wood.* *Macmillan & Co.*

6. Mind in Nature; or, the Origin of Life and the Mode of Development of Animals. By Henry James Clark, A.B., B.S., Adjunct Professor of Zoology in Harvard University, Cambridge, Mass. With over 200 *Illustrations.* *New York: D. Appleton & Co.*

7. Handbook of Natural Philosophy. By Dionysius Lardner, D.C.L. Electricity, Magnetism, and Acoustics. Seventh Thousand. Revised and Edited by George Carey Foster, B.A., F.C.S., Professor of Experimental Physics in University College, London. 400 *Engravings.* 460 pp. Crown 8vo. *Walton & Maberly.*

8. The Harmonies of Nature; or, the Unity of Creation. By Dr. G. Hartwig. 420 pp. Demy 8vo. 200 *Illustrations.* *Longmans & Co.*

9. Cholera in its Home. With a Sketch of the Pathology and Treatment of the Disease. By John Macpherson, M.D., late Deputy-Inspector-General of Hospitals, H.M. Bengal Army, and formerly of the European General Hospital, Calcutta. 160 pp. Crown 8vo. *John Churchill & Sons.*

10. The English and their Origin. A Prologue to authentic English History. By Luke Owen Pike, M.A., of Lincoln's Inn, Barrister-at-Law. 290 pp. Demy 8vo. *Longmans & Co.*

11. The Physiological Anatomy and Physiology of Man. By Robert B. Todd, William Bowman, and Lionel S. Beale, Fellows of the Royal Society, former and present Professors of Physiology and of General and Morbid Anatomy in King's College, London. A New Edition, by the last-named Author. Part I. *Longmans & Co.*

12. On the Anatomy of Vertebrates. Vol. II.—Birds and Mammals. By Richard Owen, F.R.S. 406 *Wood Engravings.* 600 pp. Demy 8vo. *Longmans & Co.*

13. Reliquæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Part II. *Baillière.*

14. The True and the False Sciences. A Letter on Homœopathy. 40 pp. Demy 8vo. *John Churchill & Sons.*

15. Rain and Rivers; or, Hutton and Playfair against Lyell and all Comers. By Colonel George Greenwood. Demy 8vo. *Longmans & Co.*

16. On the Use of the Sphygmograph in the Investigation of Disease. By Balthazar W. Foster, M.D., M.R.C.P. Lond., Professor of Clinical Medicine in Queen's College, Birmingham. 30 pp. Crown 8vo. *From the Author.*

17. Memoirs of the Geological Survey of Great Britain and of the Museum of Practical Geology. The Geology of the Country round Stockport, Macclesfield, Congleton, and Leek. By Edward Hull, B.A., F.G.S., and A. H. Green, M.A. F.G.S. With Map. 102 pp. Royal 8vo. *Longmans & Co.*

18. A Dictionary of Science, Literature, and Art. Edited by the late W. T. Brande, D.C.L., F.R.S., and the Rev. George Wm. Cox, M.A. Part IX. *Longmans & Co.*

PAMPHLETS, PERIODICALS, PROCEEDINGS OF SOCIETIES, &c.

Memoirs of the Geological Survey of India. Vol. IV. Part 3. Vol. V., Part I.

Memoirs of the Geological Survey of India.—Palæontologia Indica. 36–39, 41.

Catalogue of the Organic Remains belonging to the Echinodermata in the Museum of the Geological Survey of India, Calcutta.

Annual Report of the Geological Survey of India, and of the Museum of Geology, Calcutta. Ninth year, 1864–5.

Catalogue of the Specimens of Meteoric Stones and Meteoric Irons in the Museum of the Geological Survey, Calcutta.

On the Function of Articulate Speech, and on its Connection with the Mind and the Bodily Organs. Illustrated by a Reference to recent Observations on certain Diseased States of the Brain. By W. T. Gairdner, M.D., Professor of Practice of Physic in the University of Glasgow. 37 pp. Demy 8vo.

Case of Aphasia, or Speechlessness. By the same Author. 13 pp. Demy 8vo.

On the Physical Cause of the Submergence and Emergence of the Land during the Glacial Epoch. By James Croll. With Note by Professor W. Thomson, F.R.S. 6 pp. Demy 8vo.

On the Excentricity of the Earth's Orbit. By James Croll. 2 pp. Demy 8vo. *From the Author.*

Extracts from the Proceedings of the Academy of Natural Sciences of Philadelphia, Papers on New Mollusca. By Isaac Lea. 32 pp. Royal 8vo. *From the Author.*

Description of a Double Fœtus. By Jeffries Wyman, M.D., Hersey Professor of Anatomy in Harvard College. 10 pp. Demy 8vo. *Boston, U.S.A.*

Report of a Committee appointed to consider certain Questions relating to the Metropolitan Department of the Board of Trade.

Observations and Experiments on the Effects of Prussic Acid on the Animal Economy. By T. S. Ralph, M.R.C.S. (Read before the Medical Society of Victoria, December 6, 1865.)

Index to the Foreign Scientific Periodicals contained in the Free Public Library of the Patent Office.

Brief Remarks on Cholera: being the Result of Observations during the two last Outbreaks of Cholera in England, &c. To which is added, a Short Table of Practical Rules for general Use during an Epidemic. By R. J. Spitton, M.D. *Churchill & Sons.*

The Action of Fungi in the Production of Disease. By Tilbury Fox, M.D. London. 21 pp. Demy 8vo. *From the Author.*

On the Deposits occupying the Valley between the Braddons and Waldon Hills, Torquay. By W. Pengelly, F.R.S , F.G.S. &c. (Read before the Torquay Natural History Society, May 9, 1866.)

On the Origin of Muscular Power. By Dr. A. Fick, Zurich, and Dr. J. Wislicenus, Zurich.

Report on the Health of Liverpool, during the year 1865. By W. S. Trench, M.D., Medical Officer of Health.

Speculations on the former Topography of Liverpool. Part I. By Joseph Boult, F.R.I.B.A. *Liverpool: Brakell.*

On Kent's Cavern, Torquay. By W. Pengelly, F.R.S., F.G.S., Lecture at the Royal Institution.

North Staffordshire Naturalists' Field Club. 1866. Report. 10 pp. Demy 8vo.

Proceedings of the British Naturalists' Society, with the Annual Report, Treasurer's Account, and List of Members. Edited by W. Lant Carpenter, B.A., B.Sc., Honorary Reporting Secretary. 24 pp. Demy 8vo.

The Printers' Register.

Westminster Review, April. *Trübner & Co.*

Geological Magazine, April. *Trübner & Co.*

The American Journal of Science and Arts.

Journal de Médecine Mentale, Fév. *Masson et Fils.*

Bulletin Mensuel de la Société Impériale Zoologique d'Acclimatation, Avril.

Scientific Review.

American Journal of Mining.

Proceedings of the Royal Society.

" " Royal Astronomical Society.

" " Royal Geographical Society.

" " Chemical Society.

" " Geological Society.

" " Zoological Society.

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MAP
OF THE
COAL FIELDS
OF THE
WORLD
NORTH AMERICA
SOUTH AMERICA
EUROPE
ASIA
AFRICA
AUSTRALIA
REFERENCE
1 England & Wales
2 Scotland
3 Ireland
4 France & Belgium
5 Saarbrück Prussia
6 Hanover & Westphalia
7 Bohemia & Silesia
8 Poland
9 Turkey
10 Spain & Portugal
11 Eastern & Western Russia
12 Central Russia
13 Southern . Donetz
14 Asiatic Turkey
15 India
16 China
17 Japan
18 Borneo
19 Australia
20 Tasmania & New Zealand
21 Brit Possessions N America
22 United States &c
23 Vancouver Isd &c
24 Brazil
25 Africa
Extension of Coal deposits
Lignite

45

THE QUARTERLY

JOURNAL OF SCIENCE.

OCTOBER, 1866.

I. OUR COAL SUPPLIES AND OUR PROSPERITY.

With a "Coal Map" of the World.

In the year 1862, Mr. Edward Hull, of the Geological Survey, published a small compact work on the coal-fields of Great Britain, in which he incidentally discussed the question "How long will our Coal-fields last?" and replied by expressing his belief that they would last upwards of 1,000 years, at the then rate of production. In 1863, Sir Wm. Armstrong, the President of the British Association, in his address at Newcastle, took up the inquiry in what was at that time considered rather a sensational spirit, and declared the probable limit of the coal-fields to be about two centuries.

In 1865, Mr. W. S. Jevons, M.A., published a work on the "Coal Question," with "an inquiry concerning the progress of the nation, and the probable exhaustion of our coal supply;" in which he said, "If our consumption of coal continue to multiply for 110 years at the same rate as hitherto, the total amount of coal consumed in the interval will be one hundred thousand millions of tons;" and as Mr. Hull, whose figures he adopted, only estimated the whole available resources of the country at about eighty thousand millions of tons, there is, according to Mr. Jevons's view, a fair prospect of our supply being entirely stopped within a century.

When the startling work of Mr. Jevons was given to the world, the sensation created by Sir Wm. Armstrong's remarks at Newcastle had somewhat subsided, and the book was neglected until Mr. J. S. Mill, the political economist, took up the subject of the reduction of the national liabilities in the House of Commons last spring. He did not exactly say that he agreed with Mr. Jevons's calculations, but he gave them sufficient weight to justify their employment for the end he had in view, and his argument may thus be briefly stated: "We are fast consuming the stock-in-trade of our posterity; do not let us bequeath them our debts."

The Chancellor of the Exchequer (Mr. Gladstone) found this a convenient lever to enable him to introduce a measure having the object proposed; for whilst the less scientifically-informed members of the Lower House were compelled to look on with astonishment, and dared not open their lips in the presence of so inexorable a schoolmaster as Mr. Gladstone, the initiated smiled, and allowed the effort to be made to diminish the national indebtedness—a very wise course on the part of both sections of the House.

It is right, however, that we should, *en passant,* remind our readers that not alone is the credit of having awed the House of Commons due to Mr. Jevons, but that they will find in the penultimate chapter of his work the suggestion thrown out that the effect of the rapidly decreasing coal-supply should be counteracted by the reduction of the National Debt.

No sooner, however, was the financial measure brought in, than other gentlemen in the House of Commons, practically acquainted with the question, called upon the late Government to appoint a Commission of Inquiry; and shortly after the subject was introduced by Mr. Mill, such a Commission was nominated, which is at present prosecuting its labours.

It is, of course, well known to our readers that the change of ministry brought also a changed financial policy. Mr. Disraeli withdrew the measure which was intended as the commencement of a new account in our national ledger, and all we have left now is the cry of dwindling coal resources and a Royal Commission of Inquiry.

No doubt these gentlemen will in due time present a Report to Her Majesty, which will be full of valuable information and suggestions; but as we apprehend that all the data for arriving at a sound conclusion (or as we shall presently seek to show, for *not* being able to arrive at a positive conclusion,) are as ripe now as they will be when a Report is issued, we shall venture to lay before our readers the best information at our command, and such views as we trust will at least have the effect of calming apprehensions that might otherwise be kept alive until the Report of the Commission is presented and published.

And let us first state, with regard to Mr. Jevons's book, which has created such a hubbub, and in which, a long year after its publication, our legislators and critics have discovered so much profound wisdom, that it presents evidence of honest care and perseverance; contains a great number of valuable facts intermingled with conscientious but erroneous opinions; and that whilst many of the generalities uttered by the author are undoubted truths, which might have been deduced with equal if not greater justice from facts totally unconnected with "the Coal Question," it unfortunately attributes the decline which the author apprehends, as it temporarily props up the supremacy of our people, upon an unstable materialistic support which really has very little to do with the permanent foundations of our imperial grandeur and national prosperity.

We shall not merely content ourselves with thus passing judgment on the book; in the course of our inquiry some of Mr. Jevons's thoughts will serve as our points of departure, although it will appear that they lead us to conclusions totally at variance with those of the author. This book may be reviewed in the identical terms which he, curiously enough, applies to the opinions of one of the earliest writers on the subject of which he treats, *viz.* "The Reputed Quantity of Coal of Britain." "His remarks are highly intelligent, and prove him to be one of the first to appreciate the value of coal, and to foresee the consequences which must" (we should rather say "might") "some time result from its failure. This event he rather prematurely apprehended." . . . "Still his views on this subject may be read with profit even at the present day."

We propose to conduct our inquiry as follows:

First. We shall inquire: What are the present sources of our coal supply in Britain?

Secondly. Are those sources likely to extend? May we, in the course of time, have greater facilities for obtaining coal in Britain than we at present possess?

Thirdly. Are there any means by which such additional supplies should now be sought or encouraged?

Fourthly. How is our present supply consumed?

Fifthly. What general changes are likely to occur in the application of our coal resources?

Sixthly. From the foregoing, we shall endeavour to arrive at some conclusion as to the probable future of Great Britain, as it is likely to be affected by changes in our manufacturing industry, consequent upon a modification of our coal supply.

In all these inquiries our words must necessarily be few, and as we have derived our information from the best sources, we must leave it to our readers to employ the best means at their disposal for the rectification of our errors, if they should have difficulty in accepting any of our statements.

First, then,—"What are the present sources of the coal supply in England and Wales?"

From 17 coal-fields (of which 3, Anglesea, the Forest of Wyre, and Shrewsbury, are inconsiderable), which may be arranged under three groups: 1, The Eastern; 2, Western; and 3, Southern.* The coal-fields of Scotland, 6 in number, form another group, the Northern. The yield from the whole of these coal-fields was 98,150,587 tons in 1865.† If we take the estimate of Mr.

* See 'Quarterly Journal of Science,' No. 1.
† Mineral Statistics. R. Hunt, F.R.S.

McCulloch of the yield in 1840 at 30,000,000 tons, the total increase in 25 years will have been about 68,000,000, or at the rate of 2·6 millions per annum, which was nearly the amount assumed by Sir W. Armstrong (2,750,000 tons per annum).

There is no probability of absolutely new sources of supply beyond these coal-fields and their marginal tracts of Permian and New Red Sandstone. The geological evidence is against the supposition of the existence of coal under the Eastern and Southern counties of England, with the possible exception of a narrow trough under the cretaceous rocks of the Thames valley. This is owing to the uprising of the Silurian rocks beneath the newer formations of which we have indications in Leicestershire, Warwickshire, South Staffordshire, and Shropshire. It is also certain that the Somersetshire coal-field terminates to the eastward under the lias, and is disconnected with any possible coal-strata under the Thames valley.

There are several coal-fields of which it may be confidently affirmed that they have passed their prime, and are verging on decay; of these the coal-fields of Coal-brook Dale, in Shropshire, the Flintshire, and the South Staffordshire are the examples. There are others which have nearly attained their meridian of development, such as Durham, Lancashire, Warwick; Yorkshire, Derbyshire, and Notts (all one); and there are others which are capable of considerable increase in the amount of their yield; of which the examples are Denbighshire, North Staffordshire, Leicestershire (especially under the adjoining New Red Sandstone areas), Forest of Dean, and South Wales. Some districts of the Scottish coal-fields have also seen their best days, but on the whole the resources of the coal area of Scotland are on the same parallel as those of England and Wales.*

The following is a summary of the outputs of the coal-fields from the mineral statistics of Great Britain for 1865.†

		Tons.	Condition.
1.	Durham and Northumberland	25,032,694	(increasing)
2.	Cumberland	1,431,037	(increasing)
3.	Yorkshire, Derbyshire, and Notts	15,046,350	(increasing)
4.	Leicestershire	965,500	(increasing)
5.	Warwickshire	859,000	(increasing)
6.	Staffordshire and Worcestershire	12,200,989	(increasing)
7.	Lancashire } one coal-field	11,962,000	(increasing)
8.	Cheshire } one coal-field	850,000	(increasing)

* An interesting inquiry into the actual quantity of gas-coal, or cannel, in the United Kingdom, has just been concluded by Mr. R. Hunt, F.R.S., and is addressed to Messrs. Baxter, Rose, Norton, and Co., of Westminster. From this it appears that the total quantity of this valuable mineral is very limited; that the present supply of 1,418,176 (1865) might be increased to 3,172,000, which would go far towards exhausting the mineral in a period considerably less than half-a-century.

† Mineral Statistics. R. Hunt, 1865.

		Tons.	Condition.
9.	Shropshire	1,135,000	(declining)
10.	Gloucestershire, Somersetshire, and Devonshire	1,875,000	(ditto)
11.	South Wales coal-field (including Monmouthshire)	12,036,507	(increasing)
12.	North Wales	1,983,000	(increasing)
13.	Scotland	12,650,000	(increasing)
14.	Ireland	123,500	(declining)

The total output was 98,150,587 tons from 3,256 collieries; but the present progressive or retrogressive state of any of the above coal-fields is not always a criterion of their resources.

We now enter upon our second inquiry:

Are our sources likely to extend, or may we in the course of time have greater facilities for obtaining coal in Great Britain, or from other countries, than we at present possess?

It is hardly necessary to remind our readers that upon the replies to this inquiry mainly depend the estimate of the probable duration of our coal-fields. Let us therefore ask, first: Will improved systems of mining and ventilation enable us to procure coal below 4,000 feet, calculated by Mr. Hull to be the extreme depth? The answer involves many important considerations.

It may probably be admitted that high temperature can never prove a serious impediment to deep mining. Mr. Vivian has, we think, disposed of this question;* as it is one which may fairly be left to the progress of invention to solve. As Mr. Vivian remarks, "If heat were produced by additional barometrical pressure, it was equally true that by rarefaction we produced cold;" and he states that the process of rarefaction by machinery is now employed in the deep mines of France and Belgium. Although there is therefore no reason for supposing that the calculation of Mr. Hull of the combined temperature of the strata and air (120° F.), at a depth of 4,000 feet is incorrect, yet it is one of those objections to deep coal-mining which may safely be dismissed. This we believe to be Mr. Hull's present opinion.

A more formidable obstacle is likely to be found in the pressure of the superincumbent strata. And this may be experienced, not so much in the greater density of the coal, as in the difficulty of supporting the roof and sides of the air-passages, and the "goafs," or chambers from which the coal has been extracted. Already, with our comparatively shallow mines, this is often a difficulty; and how much greater is it likely to become, when instead of dealing with a pressure from 2,000 feet of strata, the depth is doubled. It is generally supposed that when the coal is removed the overlying strata form a natural arch which at first supports

* His 'Speech.' Ridgway, 1866.

the roof. This may be, when the strata are unbroken by faults or fissures over wide areas; an exceptional state of things. In such a case Mr. Vivian's analogy of "the small hole in the wall"* holds good, but if the cohesion of the beds is destroyed by ruptures (a very common occurrence in the form of joints and faults), we may expect the weight of the strata to exert an irresistible effect. We have been strongly impressed with the force of this reasoning, by a case which occurred in Dukinfield colliery, as stated by the manager about two years since. In the workings of the coal, 4½ feet in thickness, at a depth of 2,500 feet from the surface, the pressure was found powerful enough to crush in circular arches of brick-work, four feet in thickness; and in one instance a pillar of cast-iron, 12 inches square, 4½ feet in height, and supporting a roof of only 7 feet square, was snapt in twain.

Notwithstanding these considerations, we cannot but feel that in questions of this kind experience is likely to be the only safe guide, and we think this is one of the points on which the Royal Commissioners ought to ascertain the experience of the colliery managers and viewers of the deeper mines throughout the kingdom. Admitting, for the moment, the possibility that neither temperature nor pressure is likely to be found an insuperable obstacle even at the depth of 4,000 feet, we may confidently assume that only coal-seams of superior quality and thickness, capable of being mined economically, will be followed to this or any greater depth. The question of outlay of capital and additional cost per ton due to increase of depth, becomes formidable, and as Mr. Jevons has shown, this will be the last court of appeal in all questions of mining. To open out a colliery at the present day to a depth of 600 or 700 yards, cannot be accomplished under an outlay of 100,000*l.*, which sum has to be recouped in a term of twenty-five years or so, and to bear interest at the rate of 10 per cent. in order to form a successful speculation, and this can only be done where the seam is of good quality, proper thickness, and comparatively free from accidental irregularities, such as rock-faults, dykes, and "horse-backs."

When therefore the outlay comes to be nearly a quarter of a million, as it assuredly will be when the depth is 1,000 yards and upwards, instead of 600 or 700, we may feel sure that only seams of superior excellence will justify such an outlay. It is therefore inconvenient to adopt any sharply-defined limit of depth, as we may easily conceive the case of a seam of coal of such value, that it might be followed even to a greater depth than 4,000, while we may safely conclude that there are very few seams in any coal-field which will eventually justify such an effort. Still, admitting this,

* "The fact was, that you might make a small hole in a wall and yet not cause the wall to tumble down."—His 'Speech.' Ridgway.

we cannot grant all that Mr. Vivian demands in his estimate of the resources of the great South Wales coal-field. Not one of Mr. Vivian's mines in South Wales has reached one-half the depth of which he makes so small an account, and yet he must have a tolerable experience of the difficulties and outlay of mining by machinery even to the moderate depth of 400 or 500 yards. If it were taken for granted that because the coal is *there* it must be accessible, the Royal Commission would not be needed.

Let us now ask: Are we likely to procure a supply from below the sea, or estuaries of Great Britain?

The districts in which coal-measures extend under the sea are certainly few, considering the large areas the coal-fields occupy in the land. We cannot expect any great addition to our supply from these tracts, as it is evident the entrance to the mines must be always above the limit of high tides. In Cumberland, Flintshire, and a few other places, coal has been worked under the sea with success for many years—one of the mines at Whitehaven extending 3,200 yards from the shore. In Scotland the coal formation constitutes the sea-board of parts of Ayrshire, Fifeshire, and the Lothians. In England we may expect a very large quantity of coal to be recovered under the sea between the north of the Tyne and the Tees, provided great care be taken to leave barriers for stopping off the waters for some distance from the outcrop of the seams downwards. We may also expect at some future time, coal to be wrought under the estuary of the Dee, and possibly that of the Mersey, and again along the coast of the Vale of Clwyd near Rhyl. But the most important tract is that which is covered by the waters of Swansea and Carmarthen Bays. In the latter case many hundreds of acres of the lower and most important seams are under water, and we shall not be surprised if, at some future time, steps be taken to reclaim from the ocean by embankments a sufficient extent of the estuary to allow of the recovery of the whole of the coal.

To this inquiry let us add the parallel one: In what districts and under what formations *may* there be coal still undiscovered?

It is perfectly true, as stated by Mr. Vivian, that some of our coal-fields are merely outcropping portions of larger concealed coal-fields. If we take the Lancashire and Cheshire coal-field on the North, the Flintshire, Denbighshire, and Shropshire coal-fields on the West, the North Staffordshire coal-field on the East, and the South Staffordshire coal-field on the South, we inclose an enormous area under nearly the whole of which we may safely state that coal exists within a depth of 5,000 feet of the surface.* If we were to adopt a limit of 4,000 feet, the area would be considerably reduced,

* See Map of the Coal-bearing Tracts of Great Britain, 'Quarterly Journal of Science,' No. 1. Also, Hull's 'Coal-fields of Great Britain.' Second edit.

especially in Mid-Cheshire; but within this latter depth there are large areas in Leicestershire, Warwickshire, Staffordshire, Notts, and probably the eastern districts of Yorkshire, along a band of country ranging from the estuary of the Tees southward by York, and crossing the Humber near Goole. This tract is overspread by Liassic and Oolitic formations, containing the ironstone of the Cleveland Hills; and if Mr. Vivian's somewhat sanguine views as regards depth be adopted, it would be quite possible to conceive of a shaft entering the ground at the outcrop of the Liassic ironstone, and penetrating to the underlying coal; the depth, however, would be considerably greater than 1,000 yards over the whole district.

Into the overlying Permian and Triassic formations, collieries have already advanced to a considerable extent. The Magnesian Limestone of Durham, Yorkshire, and Notts has been and is being pierced by many shafts, while the water which saturates this and the underlying Permian Sandstone, and which at first was a formidable impediment, is pumped for the supply of the towns. The New Red Sandstone along the southern margin of the Lancashire coal-field, as also that near Rugeley, Cannock Chase, and Ashby-de-la-Zouch have been pierced, and the underlying minerals won; while in Somersetshire, owing to the thinness of the Triassic rocks, the Lias itself has been pierced by several collieries. Thus has been commenced a phase of coal-mining under the overlying geological formations, destined at no distant day to assume much larger proportions.

While maintaining that there are very large areas—larger in fact than the areas of the English and Welsh coal-fields themselves—which contain coal overlaid by Permian, Triassic, and Liassic formations, we at the same time hold that this area has been overestimated both by Mr. Vivian and those who have given an opinion on the subject. We concur with Mr. Jukes* in his view that the coal-measures were never deposited in that part of Worcestershire south of the Clent and Licky Hills; and Mr. Hull has shown that, both from the thinning away of the coal-measures towards the south-east, and from the uprising of the Old Silurian rocks during the coal period, we are not to look for coal under the eastern counties of England. The discovery of slate rock at a depth of 1,035 feet at Harwich, beneath the Cretaceous formations, is significant evidence of the credibility of these conclusions.

The foregoing considerations lead us to pause for a moment in our inquiry, and to ask our readers whether, provided these views be correct, all calculations as to the probable duration of our coal supply are not at once invalidated by the fact that it is at present beyond the power of any living person to estimate what that supply

* 'The Geology of the South Staffordshire Coal-field.' Mem. Geol. Survey. Second edit.

is likely to be. The depth to which mining may be carried (*for the coal is there*), the probable stores beneath the sea, under our rivers and estuaries, and the extension of the present fields, are, we maintain, questions at present so vaguely defined and so incapable of a satisfactory solution, that it matters little in what ratio the consumption is likely to increase. Before a man is in a position to decide how long a newly-acquired fortune is likely to last, he should at least be certain of its amount, or his estimate of its probable duration is worthless.

Proceeding practically in our inquiry, we shall for the present dismiss from our consideration all means of obtaining fresh data for arriving at an estimate of our future resources, except that of "boring" for coal in suspected new fields.

On principle, we are by no means favourable to the grant of public money for the prosecution of borings in search of coal: first, because the benefit or damage, as the case might be, could only accrue to private individuals on whose property the experiments would be carried out; secondly, because we are not at present, nor shall we be for a long time to come, in such need of additional coal-ground as to necessitate experiments of this kind; and chiefly, because we believe that when the time does arrive that such experiments are needed, *they will be carried out by private enterprise, which in this country generally manages matters of this kind better than the Government.* At the same time, as the subject has been pressed on the attention of the Royal Commissioners, and they may possibly come to the resolution to recommend Parliament to make several experiments with the public money, we now suggest the following localities for boring; the actual sites in each case would of course require mature consideration.

Cumberland—St. Bees.

Cheshire—1. The valley of the Dee, near the City of Chester. 2. The promontory of Wirral, about two miles south of Birkenhead, on the banks of the Mersey. 3. Also some point near Hoylake, at the mouth of the Dee.

Lancashire—A spot to be selected between Liverpool and Runcorn Gap, along the estuary of the Mersey.

Salop—1. Market Drayton. 2. Shiffnal.

Staffordshire—1. The valley of the Trent, along the northern border of Cannock Chase, near Colwich. 2. New Red Sandstone east of Stafford.

Warwickshire—In the centre of the plain of Permian beds, west of the Warwickshire coal-field.

Thames Valley—1. Reading. 2. Kentish Town; the boring already commenced to be continued.

The Weald—Tunbridge Wells.

Thus then the first three divisions of our inquiry lead us to the conclusion that whilst it is as clearly impossible for any one in the present day to estimate, even approximately, the future sources of our coal supply as it would be to compute the quantity of fish in the sea, still we have every reason to hope that, provided our consumption increases in a moderate ratio, the stores at our disposal are not likely to be exhausted even as soon as the more sanguine of our statisticians have calculated.

And now we enter upon the fourth inquiry, to form some idea as to our future *Consumption* of Coal; and here we must remark that Mr. Jevons's want of business knowledge has led him into statements which such gentlemen as Mr. Gladstone, or Mr. Mill would not be able to question, but which, as we shall show, will not bear discussion either on the basis of past experience, or of our commercial prospects.

We must begin by asking: How is our present supply consumed? No one can give more than an approximate answer to this question. The labours of the Royal Commission will doubtless throw fresh light upon it; for with such an untiring caterer as Mr. Robert Hunt, the Keeper of the Mining Records, they cannot fail to accumulate much valuable information. But for the purposes of our inquiry, and with sufficient accuracy to lend confidence to our conclusions, we may safely employ the following approximate figures:*—

	Tons.
The total quantity of coal raised in Great Britain in 1865 was about	98,000,000
Of this there were exported about	9,200,000
Leaving for home consumption	88,800,000
Say about . .	89,000,000

It is estimated that for domestic purposes each inhabitant consumes a ton of coal, and the population of Great Britain may be taken in round numbers at twenty-four millions:—

		Tons.
For domestic consumption, therefore, we may estimate		24,000,000
For all purposes of pig-iron manufacture, that is to say, for making the pig; engines, &c.	about	15,000,000
For all purposes of converting iron . .	„	15,000,000
For gas-making	„	10,500,000
For textile fabrics	„	3,000,000
For all other purposes	„	21,500,000
Total	„	89,000,000

Now let us consider these items separately; and deferring for the present the question of our coal exports, as they are intimately

* Of course these approximate figures are the result of careful inquiries.

associated with our naval consumption, we will take the subject of our domestic needs. It is estimated, as already remarked, that one ton per head of the population is the quantity so employed, and therefore it may with confidence be said that between one-third and one-fourth of our whole coal supply is burned on the domestic hearth.

In the course of his long argument, in which whole chapters are devoted to matters of secondary importance, we find only one mention of our domestic consumption of coal in Mr. Jevons's book, and the perusal of the few words on the subject (p. 103) really leaves us greatly perplexed as to the cause of his reticence. He says that "if our population could be induced to abstain from the enjoyment of a good fire, the saving effected would not extend over more than about one-third of the total consumption of coal, the domestic consumption being on an average about one ton per annum per head of the population." This may be a trifle not worthy of the consideration of a philosopher who deals in abstract questions of immense magnitude, but it is of sufficient moment to command our attention.

The increase in the domestic consumption of coal is almost sure to keep pace with increasing population, unless some substitute is found for the present uncleanly and not very healthy* method of warming our houses and cooking our food, and it would seem at present that no item in our consumption is likely to be more regular than that one.

It will be convenient first, to look at Mr. Jevons's estimate of what would be our consumption "assuming the present rate of growth, $3\frac{1}{2}$ per cent. per annum, to hold" for a century from the present time. In that case, he says, our total consumption of coal in the year 1961 would be 2,607,500,000 tons. Retaining the same proportion for domestic uses, there would be applied to such purposes between 700 and 800 millions tons of coal, and Great Britain would possess a population represented by the same numbers, 700 to 800 millions of inhabitants! We leave it to our readers who have perused Mr. Jevons's work to decide whether we are not justified in this application of his logic and statistics; in fact, such an inference appears inseparable from his argument.

In his speech on moving for a Royal Commission,† Mr. Vivian reduced another of Mr. Jevons's geometrical calculations to an absurdity, by a somewhat similar process. "If the increased consumption of coal is to be calculated by geometric progression, I have an equal right to calculate the increased production of iron in the same manner, and therefore at the rate of $5\frac{1}{3}$ per cent. per annum. But I will be merciful and take it at 5 per cent.; then 4,769,951 tons of pig-iron, increasing at the rate of 5 per cent.

* We refer to its effect out of doors.

† 'Speech on the Coal Question.' Ridgway, 1866.

per annum, will in 100 years be equal to 626,991,583 tons per annum, and 1,125,986,597 per annum in 112 years, and the coal to be used in making this iron, at the same rate for pig and wrought, would, according to this theory of geometric progression, be stated thus:—24,435,747 at 5 per cent. per annum = 3,213,331,617 per annum in 100 years, and 5,770,680,864 in 112 years. In 1961 iron would use 2,775,796,665 tons of coal. But how does this correspond with the quantity Mr. Jevons has calculated upon? He states, from statistical calculations, that the total production of our coal-mines in England must in the year 1961 amount to 2,607 millions of tons per annum to meet all the wants of England, including of course the manufacture of iron. So that we have here a very curious paradox reposing upon the incontrovertible logic of figures, *viz.* that the lesser quantity, although contained in it, still overtakes the greater, and we arrive at this ridiculous result, that the quantity of coal consumed for the making of iron alone exceeds the total quantity which Mr. Jevons lays down, according to the theory of geometrical progression, as required for the total consumption of the kingdom, including iron, 100 years hence."

We do not wish our readers to suppose that Mr. Jevons positively asserts his belief that the consumption will be so great a century hence, but he startles us with such sentences as the following (already quoted) in italics:—"*If our consumption continue to multiply for* 110 *years at the same rate as hitherto, the total amount of coal consumed in the interval will be* 100,000 *millions of tons.*" And we maintain, looking at the context, that it would have been just as sensible (or otherwise) if he had said that, should the demand for coal be further stimulated by our increasing prosperity, we *might* not have a pound of coal left in England twenty years hence! He devotes a whole chapter to the subject of the growth of our population, and we cannot find that he anywhere compares it even with any hypothetical increase in the demand for coal.

We do not pretend to express an original opinion as to the probable ratio in which our domestic demand is likely to increase. It would be absurd to do so. Already many of our cooking-ranges and stoves are heated with coal-gas. Fifty years hence they may all be heated with American or British petroleum gas, or any one of a score of old or new heat-producers; and persons who deride the idea of coal substitutes (Mr. Jevons amongst the number), have no eyes for what is passing around them. Of this, more hereafter. All we can say is that, at present, calculating the domestic consumption at one ton per head of the population, we consume about 25,000,000 tons annually; and should the population of Great Britain be doubled or trebled during the next century, the steadiest item, comprehending one-third of our whole consumption, may rise from 25 to

50 or 75 millions of tons. We, however, anticipate no such increase.

Let us now pass to the second and third items of consumption (embracing also about one-third of the whole), *viz.* coal used in the production and conversion of iron.

Mr. Bernhard Samuelson, M.P., a large ironmaster and machine-maker, expressed the view, when the coal question was first debated in the House, that if coal became very much dearer here, the export of iron from this country to many places would cease, and that the United States would beat England in neutral markets; but he might have gone still further, and might have said, with perfect truth, that not only the export trade in pig-iron, but also in some of the manufactures of iron would probably leave us. A question of equal, some think of greater importance with that of the coal supply in the production of an article of such low value as iron, is that of labour; and although there may be periods when that is high abroad, as a rule, it is greatly in favour of the continental manufacturer.

Let us mention a fact or two worthy of consideration.

Whilst coal is actually so cheap as to serve as ballast for steam-vessels to America, and in some cases to be brought back again to England (as we shall explain hereafter), locomotive engines have been made abroad (we believe by a firm in Creusot) for one of our English railways; others, by a house at Carlsruhe for Indian railways; and a large firm of English ironmasters and coal-proprietors have lately ordered a pumping-engine in Belgium for one of their Northumbrian collieries. Furthermore, the cost of iron ships has latterly, owing to increased wages both in manufacturing iron and building the vessels, approximated so closely to the cost of iron ships built in France, that very little more would turn the scale in favour of the foreign maker.

But what do these facts indicate? Certainly not that the demand upon our coal resources will increase, but rather that it will be *pro tanto* relieved, and that without a failure of our coal supplies, our industry and enterprise must be turned into new channels.

Closely connected with this part of the subject, as Mr. Samuelson showed, is that of our manufactures and exports of textile fabrics. Whilst in 1865 about 30,000,000 tons of coal were consumed in the production of a class of articles, of which we sold to foreign nations in all 9 millions worth, only 3,000,000 tons were required for the manufacture of textile fabrics, of which our exports amounted in value to 96 millions of pounds sterling. This exhibits in a most striking manner how little our coal supply may have to do with our material prosperity in the future. That we may cease to be the producers of the coarse material—iron in its various forms—is not at all unlikely, but it by no means follows that we should at once become small-ware manufacturers, that "our work," to quote Mr. Jevons, "will be that of the trinket and the watch rather than that of the herculanean engine, hand work rather than machine work." Such writers really forget that the world is in a progressive state; that there are such undertakings as telegraph cables; such trades as spinning, weaving, paper-making, printing, engraving, photography, and hundreds of old or of nascent avocations, arising out of the wants of modern civilization, and requiring not only the hand of the skilful artificer but the brain of the experienced mechanician in the machinery needed for their prosecution.

Turning now to another item in our coal consumption, that used in the gas manufacture, we find that one-eighth of our whole supply is employed to give light to our streets and houses; and to read the comments of some writers on this subject, one would imagine that it was a decree of Providence, that whilst every day new sources of illumination are discovered, vying with each other, and even with the sun himself in brilliancy, we should be condemned for ever to live in the pale, sickly, partial light emitted by a foul-smelling, explosive gas; noxious and dangerous in its manufacture, and extremely troublesome in its application. What has mankind done to merit such a sentence at the hands of our coal alarmists?

It is easy to sneer at persons who believe that substitutes will be found for coal—in this case for coal-gas—and to call them chimerical and visionary; but was not the same language held when people burned tallow and wax candles? Is it not always repeated when some old custom is about to disappear? From what source do we already obtain our most brilliant light? Our best lighthouses, few in number, are or are about to be lighted by magneto-electricity, and Mr. Wilde's recent invention, described at length in another portion of this Number,* bids fair to take the electric spark into our houses, streets, and workshops.

One of our ablest and most experienced electricians writes us as follows:—"My conclusions *were* that electricity could not be used at less than a hundred times the cost of coal. If Mr. Wilde proves his position, this view must be materially modified. The value of his machine for producing light, heat, or mechanical power, can only be determined by knowing the cost of the power by which it is driven."

The last-named inquiry will be answered presently.

But we need not even have recourse to electricity as a substitute for gas, although we repeat the conviction that before long that and other bright illuminating sources, as magnesium, will take the place of gas, oil, and tallow. Petroleum itself, the supply of which

* Where the past and future of magneto-electricity are fully treated.

appears at present to be unlimited, and to present new sources year by year, will become a most important agent both for lighting and as a motive power. "But," says Mr. Jevons, "*what is petroleum but the essence of coal*, distilled from it by terrestrial or artificial heat?"*

Here, again, the clever author of the work which has excited so much uneasiness is significantly brief, and what little he does say is hardly correct. Neither he nor any one else is justified in affirming that "its natural supply is far more limited and uncertain than coal," for it is only just discovered, and the supply in America and elsewhere appears to be almost unlimited. As to its artificial production, he says it can only be had by the distillation of "some kind of coal;" but what kind of coal is used for the purpose? Could the shale from which it is at present extracted at home be employed for any other purpose? and how much is so produced? These are questions which Mr. Jevons should have considered.

Moreover, if he recollected that petroleum is the "essence of coal," and that it is so dear as 15*l.* per ton, why does he forget that the freight from America upon an article worth 15*l.* per ton, as compared with that upon 1*l.* (which will probably be the price of native coal at the American outports before many years), completely annihilates the carrying distance between the two continents? And should petroleum come into use for engines, as well as for lighting (which recent experiments here and in the States render more than probable), the great difficulty in the way of the importation of our fuel at once disappears, and we shall have good cause to rejoice in the fact that an important source of our light and heat will be the same as that of our food, and that we shall be less dependent upon the resources of our little island. To show our readers that we are not merely theorizing, and that it is only a question of mechanical application, and consequently of the exercise of the inventive faculty, which will place other easily-obtainable substances above coal or coal-gas as illuminating and force-giving agencies, we will just transfer to our pages two or three facts from the recent address of Dr. Letheby to the British Association of Gas Managers.† First, as to heating power:—

Whilst Cannel gas raises	1,950 lbs.	water 1° Fah.
Common gas will raise	2,786 lbs.	,,
Paraffin (petroleum) will raise	3,619 lbs.	,,
Tallow will raise	5,054 lbs.	,,

Now, as regards lighting power:

When a magnesium wire the 100th part of an inch in diameter is doubled and twisted, it burns at the rate of 2·4 grains per minute, and gives the light of about 69 standard sperm candles;

* 'Coal Question,' p. 141.

† 'Chemical News,' June 15, June 22, July 6, 1866.

"an ounce of the wire is therefore equal in light-giving power to $3\frac{1}{2}$ lbs. of sperm candles." The Drummond light (oxyhydrogen) we will pass over; its power varies from 19 to 153 candles, according to the gas in which it is burned—*coal-gas being the lowest;* and as to the power of the electric light, it "varies from 650 candles to 1,444, the average being about 1,000!"

This is Dr. Letheby's opinion; but according to the view of Mr. Crookes (who, in his article on the subject, enters more fully into details), the lighting power is immeasurably greater; and when he first entered into a calculation of the cost of working Mr. Wilde's machine, he estimated roughly that it would require $11\frac{1}{2}$ lbs. of coal to produce with it a light of 4,000 candles for one hour!

The whole inquiry is still an open one, and is practically in its infancy. If we were asked to decide whether or not we should continue during the next ten or twenty years to employ coal as the direct source of our light, we should certainly answer affirmatively; but taking vested interests, gas-pipes, fittings, and all that sort of thing into consideration, we should not be disposed to give coal-gas a lease of more than twenty or thirty years. In fact, with our present information and experience, we may pronounce it the very height of absurdity to assert that, a few more years having passed over our heads, the employment of coal-gas for illuminating purposes may not begin to wane, and it would be equally foolish to deny that it may entirely cease to be used within the next fifty or one hundred years.

We cannot, however, close our eyes to the fact that an enhancement in the price of coal, to which we are liable at any time, even from the cry of coal exhaustion, might cause us serious temporary inconvenience, and this more particularly in the matter of ballasting our vessels. But even here the facts have been misconstrued, and the matter has been considered in only one of its aspects.

At present we have not only an export of about 9,000,000 tons, which gives employment to our shipping, and serves abroad as current coin in payment of imports, but a large quantity of coal is taken out by our steamers to be burned on the passage home. Should the price of coal rise at home, it would, as matters stand at present, rise also abroad, and would stimulate the production of coal out of England; thereby not only injuring our barter trade, but compelling us to have recourse to other substances of a less "paying" kind for ballast.

This is the unfavourable view of the question; but it has also a favourable aspect, and this we can best exhibit by following Mr. Jevons in another of his erroneous arguments.

More than once he draws attention to the fact* that sailing ships are gradually disappearing from the ocean, and that steamers

* 'The Coal Question,' pp. 98 and 250.

are taking their place; so that 50 years hence the former will be the canal boats of the deep, and he couples this with the circumstance that many of our steamers carry sufficient coal on the outward voyage to serve them on the homeward one also; or that cheap English coal is sent at a low rate to foreign ports to supply our sea-going steamers.

But why did the author, whilst he was looking forward 50 years, regard only so much of the probable future of our trade as would lead to the inference that our export demand might increase?

In America, India, Polynesia, Australia, the coal production is being vigorously pushed forward, and the real inquiry is as follows:

First, is it advantageous to the British steam-owner that he should, for the homeward voyages of his steamers, have to send out his coal to distant ports, or to carry it to the exclusion of better-paying freight? and secondly: Will the present state of things long continue?

The first question a child may answer. Excepting in so far as we have already shown, as a matter of profitable barter, it is by no means to the advantage of the nation nor of shipowners that they should have to carry coal; and as for the second inquiry, there is not the remotest doubt that before many years are over we shall have cheaper supplies of indigenous coal for our sea-going steamers at the foreign ports than any that *we* can provide, even at our present rates of freight. People who write and speak on such grave matters should not be content to heap together a mass of hypothetical statistics, they should descend to the investigation of actual *facts* as well, and their conclusions would be materially modified.

One of our largest steam-ship companies, trading with several American and European ports, consumes annually about 300,000 tons of coal; a large proportion of this is employed in their trans-atlantic steamers, and the necessity for ballast sometimes compels them to carry coal out to America, bring it back, and even to discharge a portion in England; this is, of course, done at a serious loss. But there are times when they are not so pressed for freight, and when the reverse is the case, or the English coal is rather higher than usual; they then purchase indigenous coal at New York or even Halifax, and they estimate roughly that *already* from 10 to 50 thousand tons of such coal, according to circumstances, finds its way annually into consumption with them. What will it be when the immense coal resources of America are developed? and when, on a larger scale, that continent shall have passed through what was our "wood age?"

In a lesser degree the same thing already holds good in the east. Borneo abounds in coal; the resources of our Indian and Australian colonies are fast developing themselves, and it will be as ridiculous to talk of sending coals there, 50 years hence, as it is now to speak of sending them to Newcastle.

This portion of the subject, too, is just beginning to be unfolded; but in order to enable our readers to form their own judgment as to whether our coal exports are likely to increase permanently, or whether they will not before long begin to fall off, and at last cease altogether, we have sketched out an outline map of the earth with its coal-bearing tracts, from which they will see what relation our coal-supply bears to that of the whole world.

From this map, which it must be remembered represents only, as it were, the nuclei of the future coal-fields of the world, it will be seen that as soon as those become developed, the fields of Great Britain will sink into comparative insignificance. At present England exports, say in round numbers, 9 millions of tons; in 1864, her exports were 7,529,341 tons.

Of these she sent 1,387,675 to France. This is certainly a large quantity, more than 1 per cent. of our whole supply, and our neighbours are likely to remain our best customers for a long time, although they are making great efforts to develope their own resources. Denmark and the Duchies took 522,683 tons, and there also our exports are likely to continue for some time. Sweden and Norway together took between 300 and 400 thousand tons, and the same remark applies to those countries. This accounts for rather over two millions of tons.

On the other hand, the exports to Spain and Portugal, Italy, the Mediterranean ports, Turkey, and North Africa, amounting also to more than 2 millions of tons, will soon be affected by the developing fields marked on our map as No. 9, Turkey; 10, Spain and Portugal; 14, Asiatic Turkey. The fields of Prussia, Silesia, and Poland (5, 7, 8) are also extensive, and will give increasing supplies to countries at present drawing upon Great Britain.

Russia takes about 400,000 tons, but possesses enormous fields (Nos. 11 and 12) partly explored, of which the extent cannot at present be computed.*

And now, if we turn to North America, which imported from us in 1864, 334,354 tons, the West Indies taking 529,361 tons, South America 415,203, together over 1,200,000 tons, we shall find that there is no reason why, in a few years hence, this export should be entirely stopped, the continent and islands referred to taking their supplies from the fields numbered respectively, 21, British possessions in America; 22, United States; 23, Vancouver's Island; 24, Brazil. Indeed, large quantities are already sent coast-

* The production of coal in Belgium in 1836 was about 3 millions, in 1865 about	9,700,000
„ „ France about	11,300,000
„ „ Russia in 1847 was about 3 millions, in 1865 about	6,300,000
„ „ The U.S. of America in 1860 was about 8,300,000, in 1865 about	14,590,000

—Hunt's 'Mineral Statistics,' 1865.

wise from the Pennsylvanian coal-fields to the West India Islands; and in addition to this, it is not improbable, as we have shown, that our ocean steamers will take a considerable portion of their supplies from these same fields, instead of carrying out an excess for the homeward voyage to England.

Looking to the East, we find that the East Indies alone took, in 1864, 603,614 tons, Australia only 13,127, and instead of being importing countries, there is little doubt that the coal-fields, No. 15, India; No. 18, Borneo; and Nos. 19 and 20, Australia and New Zealand, will not alone yield them ample supplies, but will also serve to coal the ocean steamers trading and likely to trade between Europe and those far distant regions.

We have analyzed the exports of 1864, which fell short of those of 1865 by about 1,700,000 tons, because the detailed exports of the latter year were unattainable, but our object has been to show in general terms that should the price of coal in England rise, and the numerous resources of distant countries become developed (indeed, without the first contingency), there will be a natural check upon our exports, and in time probably a *set towards* instead of from Great Britain.

There now remains for consideration one other item, or series of items which we have grouped together as a section of our coal supply, *viz.* that "for all other purposes." This embraces locomotives, factories of all kinds, and the general purposes of trade.

In some of these the consumption of coal is no doubt a material element; in none, however, is it a matter of such moment as to preclude the use of substitutes in case the price of coal should render that article unattainable. It is almost needless to refer further to petroleum; it is being successfully tried both for land and marine engines, and probably before the Royal Commission presents its Report, it will give evidences of being likely to effect a complete revolution in our heating processes.

But let the substance employed for driving our stationary and locomotive engines be what it may, it will be a matter for congratulation and not one for regret, if our manufacturing processes increase in a rapid ratio, and we shall be as well able, with improving trade, to pay a higher price for our fuel, as the labouring man, out of increased wages, is enabled to pay advancing prices for his provisions.

It has been impossible, in an article like the present, to enter with anything like detail into the consideration of this vast and complicated question; but we have endeavoured to show, in opposition to the views of those who are prematurely apprehensive of the exhaustion of our coal-supply:—

1. That it is at present utterly impossible for any one to define the boundary, either vertical or horizontal, of our coal strata, and therefore no estimates that can at present be offered are fit

data for calculation; but that it is highly probable our resources are far in excess of the views of our most sanguine geologists.

2. That, looking at the coal resources of other countries, our exports are not likely to prove a permanent drain upon our resources, and our ocean steamers will probably ere long obtain cheaper supplies for their homeward voyages than they at present draw from English collieries.

3. That any considerable increase in the cost of coal is likely to interfere materially in our iron trade, more especially the raw material;* and that it is not unlikely that we may not only have to submit to the loss of our export trade, but may even find it more economical to import various forms of iron, crude and manufactured, from foreign countries.

4. That there is no element of certainty in the continued increase in our consumption of coal for heating and lighting purposes, especially the latter; and that it is probable that the use of gas (which now takes about one-eighth of our whole supply) will, in time, be superseded by better lighting agents, just as *it* has to a large extent superseded candles.

5. That the most valuable staple manufactures of Great Britain absorb a comparatively insignificant portion of our whole coal resources, and it is to be hoped that any enhancement in the price of coal will be more than compensated by increasing material prosperity, enabling the manufacturer without inconvenience to pay such an extra cost of fuel. At any rate it is clear that a very great absolute increase may and probably will take place in our general home production and foreign barter trade in valuable manufactures, with hardly a perceptible effect upon our coal resources.

But whilst we thus join issue with the coal alarmists on these questions, we think it but due to them to admit that only good can result out of the inquiry which has sprung from the expression of their alarm. It is well, in the first place, that we should not depend too much upon one source of our mineral wealth for such a variety of purposes as we do at present. Before the outbreak of the American civil war, it would have appeared almost as absurd to cry out for new channels for obtaining a cotton supply, as it now does to express a fear of coal exhaustion, but we never know, when we have "too many eggs in one basket," what accident may overturn it. Again, it is not wise to trust too implicitly in any portion of our material wealth, because it has a tendency to make us apathetic; to cause us to "lie on our oars." And the agitation of the "Coal Question" has reminded us of our National Debt; it should remind us *how that debt was chiefly accumulated,*

* Within the last few months, however, one of our most experienced iron-masters has produced an improved quality of iron, with a consumption of anthracite coal reduced one-half. See "Chronicle of Mining," present Number.

and if we are unable at present to effect any material reduction in its amount, it may at least serve as a warning to our people, not to increase it by allowing themselves to be led into the quarrels of their neighbours!

We cannot agree with Mr. Jevons in the closing remarks of his volume (which we admire though we have submitted his views to sharp criticism), that "we have to make the momentous choice between brief greatness and longer mediocrity."

Great Britain may, if she please, remain *Great* Britain to the end. That her monarch will be the Emperor or Empress of India, and that she will send out governors to Australia for ever, we do not for a moment contend; but whether she shall be peopled with a happy and respected community for ages, long after her "coal supply" is really exhausted, depends not upon any single source of her material wealth, but upon the use which the nation makes of that wealth, and of the mental resources which have been so lavishly bestowed upon it by Providence.

Rome fell because she had become luxurious and effeminate, and wild, hardy hordes overran her possessions whilst her rulers, armies, and citizens revelled in luxury and licentiousness. *Spain was ruined through the mineral resources of her colonies*, and her "influx of gold" has become a bye-word to nations.

The life of a people is the reflex of that of an individual.

Great Britain harbours within herself all the elements of a long life, by the side of the most dangerous materials of corruption and premature decay, and it depends upon herself which shall predominate. Will her labouring population become more sober; or will they, with increasing means, indulge more freely in the enervating cup of intoxication? Will her middle classes allow their thoughts to be absorbed by trade, or by objects of petty ambition; or will they cultivate the arts, the sciences, literature, and true religion? Will her nobles cease to consider themselves differently constituted to their inferiors, and, neglecting their own education, endeavour to maintain their position in society by keeping down those below them; or will they avail themselves of their wealth, leisure, and opportunities to become the shining lights of the nation? These are questions in relation to our continued greatness, of far higher moment than our "coal resources," and it should be the aim of our people, not solely to accumulate wealth; not only to maintain the supremacy of our navy, or of our army, or to secure the possession of our colonies; but also to prepare by a temperate and peaceful manhood, by setting a good example to our more impetuous neighbours in the vigorous period of our national existence, to pave the way for a peaceable and respected old age, and for what few great nations, if any, have yet experienced, the "*decline*," without the "*fall*" of our empire.

II. THE PUBLIC HEALTH.

On the Sanitary Condition of Hull, Bristol, Glasgow, Leeds, Manchester; and on The Sanitary Act, 1866.

In resuming the consideration of the all-important subject of the present article, it will be convenient that we should refer cursorily to our remarks on the Mortality of Liverpool, published in the last number of this Journal.

We there showed that the high rate of mortality in that important seaport was the index to a sanitary, or we should rather say an insalubrious condition, highly favourable for the importation of Cholera into England; inasmuch as Liverpool is the chief station on the high road for emigrants and others likely to convey the infection from abroad into Great Britain.

Quoting the Report of the Local Medical Officer, we stated the causes of the high mortality to be zymotic diseases arising from overcrowding, drunkenness, and other forms of immorality which lead to poverty and destitution.

When we came to inquire into the means taken by the authorities for ameliorating the condition of the poor, we found these to be the most meagre and insignificant, for whilst very large sums had been expended to benefit the gentry and the wealthy tradespeople, miserable grants were doled out for the improvement of closed courts and untenantable houses, and the interests of the public were found to be sacrificed to those of private individuals, to the whims of local cliques, or to the exigencies of local politics.

These startling revelations carried us to the inevitable conclusion, that it would be necessary to appoint a special Committee of the House of Commons to deal with a matter of such grave national as well as local importance.

But whilst we penned these remarks, severe as they may have seemed to many of our readers, and just as they were acknowledged to be by the Liverpool journals, we were little aware of the sad and culpable neglect of which the local authorities, not only in Liverpool but in many of our other large towns, have for years past been guilty towards their defenceless poor; and when, to the reports of credible informants, we added a close personal inspection, we found a state of things so revolting that we rejoice not to have known it previously, for we should else have been tempted to print in these pages an account of facts, which at the present day would be deemed shameful, and which to posterity will appear incredible.

The anticipated Public Health Bill, to which we shall refer presently, and other causes have conduced to the amelioration of those conditions in Liverpool and Leeds, and it is our intention to refer to them only, so far as it may be necessary for awakening shame in those towns which obstinately refuse to remove similar stains from their municipal escutcheons, and who persist in setting their poor denizens an example of slovenliness and filth.

Deplorable as it may appear, it is nevertheless true that the only efficacious agents in sanitary reform are terrible visitations of disease, or stern compulsory legislative enactments. Both those agents are at present in active operation amongst us. Cholera, of which, in common with our cotemporaries, we predicted an outbreak during the summer, is committing havoc among our people; and before the prorogation of Parliament the Conservative Ministry wisely sought the co-operation of the Liberal framers of the Public Health Bill, and with their aid pressed it rapidly through Committee, under a cross-fire of obstructives, whom we should hardly have expected to find amongst our enlightened legislators.

We have to thank Providence for a visitation of Cholera, and to pray that the nation may not only be patient in enduring it, but ready to profit by the infliction; and we have also to be grateful to one who has had the decision and wisdom to insist upon sanitary reformation in all our towns and villages, to the Right Honourable Henry Austin Bruce, who (assisted by the late Home and Irish Secretaries) introduced the Public Health Bill, and who, whilst in the cold shade of opposition, was patriotic enough to see that it should became law.

Of the salutary effect of a severe outbreak of disease upon the inhabitants of a neglected town, it would hardly be possible to find a more striking illustration than the first on our list, *Hull.*

In the year 1848–9 Hull was visited by Cholera of more intense severity than any town in England. Lying low, and bordered on one side by marsh-land, it added bad drainage and a defective water-supply to its natural disadvantages; but about the time of the visitation it possessed a mayor of peculiar ability and merit, who rendered such services to the town in the matter of sanitary improvements, that when Her Majesty visited Hull, she knighted Mr. now Sir Henry Cooper, and in conferring the honour she announced to him that she had done so at the express wish of the inhabitants for the services to which we have referred.

The death-rate of Hull in the year 1851, when the Improvement Act was passed, was 36, whilst in July, 1866, when that of London was 22, Leeds 36, and Liverpool 37·6, that of Hull was less than one-half the last named, 18·3. The average mortality of the borough is however not so favourable, as will be found hereafter.

By the time our readers have accompanied us to the end of our task, they will understand the feelings of pleasure with which we record the facts that the Hull Board of Health, presided over by the Mayor, is composed of energetic men, who have effectively organized themselves for sanitary purposes; that the night-soil of the town is collected before nine o'clock in the morning, and deposited either close to the boundary, or in the case of the most important parish, Sculcoates, beyond the boundary, and the depôts are shortly to be still farther removed.

It is to be regretted, however, that there, as in all other large towns from which we have gathered information, it is not the practice to use disinfectants.

Hull was formerly ill-provided with water, but we believe its wants are now tolerably well met. Its low situation is very disadvantageous for sewerage, but, as far as we can learn, its arrangements in that respect are good. Very extensive drainage works are being carried on, and the sewers of the old town are flushed by the docks from which a sufficient fall is obtainable, and in the remaining parts of the town they are cleansed by the admission of the tide; the whole being periodically swept out.

Formerly the town had to suffer much from the boiling of whale-blubber, but with the departure of what was at one time its staple trade, the whale-fishery, the nuisance referred to has disappeared, and in its place the visitor experiences the healthy and not disagreeable odour of its numerous seed-oil and cake manufactories.

Let not the inhabitants, however, relax their exertions to keep their homes healthy, for even there it would not be difficult to point out unhealthy courts, alleys, and streets. Hull does not, however, suffer from any monstrous evil, or train of nuisances, which is more than can be said for *Bristol*.

There is no want of sanitary government at Bristol, but rather the reverse; and a certain old proverb concerning an excess of *chefs-de-cuisine* is verified. There is a Board of Health, and also a Committee of Health. The former constitutes the "Sewer Authority," and has performed much useful work in sewerage, the erection of drinking fountains, public boxes for the reception of refuse, &c. The other sanitary body, the "Health of Towns Committee," emanates from the Corporation of the Poor, and has an officer of health for the whole city with the somewhat meagre salary of 200*l.* or 300*l.* a-year; besides, there are subordinate health officers in each district, medical men, who, if we understand aright, have no salaries beyond those dependent upon their inadequate poor-law appointments. The Clifton Union have also appointed an officer of health for that district, with a separate salary.

The Health of Towns Committee is prompt and energetic in emergencies, such as visitations of typhus or cholera, but, as our readers will doubtless have anticipated, the two Sanitary Corporations here (as elsewhere under divided authority) are often at variance. And when this article was written it was found that the Privy Council order affecting towns such as Bristol, would create greater confusion and squabbling.

And well they may, for although Bristol does not at present show a high rate of mortality as compared with some large towns, its internal condition is such as to render it nationally dangerous, for it must not be forgotten that, like Liverpool, it is a large seaport at which vessels are continually arriving from foreign parts.

No hospital exists there for the reception of epidemic or contagious diseases. The Bristol Royal Infirmary and the Bristol General Hospital are authorized by their rules to refuse admission to all cases of this kind.

A temporary fever hospital was erected last year, but when typhus disappeared this wooden shed was demolished. A large building was placed at the disposal of the city by the liberality of one of the Corporation of the Poor (H. W. Green, Esq.) for the reception of cholera patients, but owing to the opposition of one of his tenants he was compelled to withdraw the gift.

Formerly, St. Peter's Hospital was devoted to the reception of medical cases, and was, in effect, the fever and lock hospital of the city; but on the day when the Corporation of the Poor became subservient to the Poor Law Commissioners, the citizens of Bristol lost the accommodation of St. Peter's as a public hospital; it is now a simple "Union."

We now approach a subject which, from its repulsive nature, has occupied but little of the attention of sanitarians, but which we believe to constitute one of the chief elements in the consideration of the mortality rate of large towns, namely, the removal of night-soil and refuse.

In Liverpool, at the time of the publication of our last article, a large portion of it was deposited on wharves, on the banks of the canal, and in the heart of the vast fever district of the borough; and although the local authorities managed not to see it in that light, there can be little doubt that the endemic typhus there has to a great extent resulted from that cause; or at least it tended largely to its maintenance.

In Bristol the night-soil is removed by the sewers; partly by the old systems, which are small and inadequate, and partly by the new sewers, not yet fully completed; and even where completed, they are not sufficiently brought into use, as the private sewers have not been extensively joined to the large common trunk sewerage canals. Many of the old sewers open into the river Froome, which runs through the city and even opens into the floating-harbour, which is a stagnant body of water, partly tidal, partly fresh, and in the very heart of the city, and at times most offensive from heat and decomposition of fœcal and animal matter. This water is changed *only once a fortnight*, even in summer time, and less often in winter. The commercial interests at stake prevent the change of this festering ditch being more frequent, as the whole of the naval commerce of Bristol is dependent upon this floating-harbour.

The Froome has been an open ditch from the formation of this harbour, and is filthy in the extreme; it has been partially covered over within the past three or four years. In its vicinity the former outbreaks of cholera occurred and the fever nests of the city exist. The Froome is the principal cause of pestilence in Bristol, as it is a grand system of open sewage still in use, unfortunately, as it is at times nearly stagnant, and always foul. The new sewers open in two places into the tidal river Avon, and have no connection with the floating-harbour.

One at the Underfall Dam in St. Philip's, near the Great Western Railway Terminus, and the other below St. Vincent's Rocks. One (the first) will cause the sewage to pass through the New Cut, part of the Hotwells, and below Clifton, to mix with the second mass of fœcal matter and run to the Severn together, and both will render it liable to be *washed back* by the rising tide to Bedminster and other districts, and even into Cumberland Lock and Floating Harbour. It is the opinion of persons well qualified to judge on such matters, that a great mistake has been made here, and that the engineers of the work are to blame for this breach of hygienic laws. This extensive sewerage work has produced considerable disturbance of the ground, and in many instances has fatally damaged the wells of Bristol, some of which have become so highly charged with animal matter as to be extremely deleterious. But the Bristol waterworks have supplied most of these districts with a very pure river water, rising on the Mendip range of hills, generally sufficient for the demands of the public, except in the height of summer and in very dry seasons, when it fails sadly. At night, too, there is no supply even for fires until the company *turns it on!* When the reservoirs are full, there is sufficient pressure to send the water even to the top of Clifton, an elevation 280 feet above the sea level. The Bristol Waterworks Company should be compelled by Act of Parliament to considerably increase their sources of supply, and the landlords should also be compulsorily obliged to obtain an adequate water-supply from the Company for their various tenants, especially in the poorer districts, where the wells are shallow and bad.

No disinfectants are anywhere used to decompose the sewerage matters.

In addition to the local nuisance occasioned by the great open sewer, the Froome, there are many objectionable factories, all of which vomit forth volumes of smoke into the atmosphere, no provision having been made for the consumption of this material. The atmosphere is very impure from this circumstance, and at times impervious to actinic power.

There are some distilleries, which at times throw off large volumes of the vapour of fusel oil, when clearing their apparatus for a fresh charge; several sugar refineries, which poison the atmosphere with the disgusting odour of raw sugar during the blowing-up process; several tallow-chandlers and grease refineries, from which issue the vile odours of melted fat and animal matters in a state of decomposition.

Bone works are also present, whence the odours of burnt bones and fetid ammoniacal matters mix their repulsive stenches, poisoning the air for miles around; also chemical manufactories, whence sulphurous and hydro-chloric acids diffuse themselves far too plenteously into the winds of heaven, and from which the effluvia of waste black ash or soda waste emanate, creating great nuisances to all around their influence.

Then the gas-works add their quota of vile odours by discharging large quantities of fetid lime out of the purifying vats, which also sometimes poison the wells by furnishing hypo-sulphite of lime to the various mineral constituents of the springs.

The slaughter-houses, skin depôts, and various tanneries may also be added to the list of local nuisances, many of the latter existing along the line of the open Froome, and poisoning the neighbourhood by their open fleshing-pits for depilating the hides and skins. These being now within the boundary of the rapidly extending city should be all closed by the powers of the Board of Health.

In spite of all these causes of disease and mortality, the death-rate of Bristol has been very much lower than many of the other large towns of England, as shown by the Registrar's Weekly Returns.

Frequently the rate has been *one* of the lowest, sometimes not higher than 18 or 19, but 22 to 25 per 1,000 being the average mortality, which was only exceeded last year during a few weeks, when typhus got the better of the medical profession and the defective sanitary arrangements of the city.

The general impression which strangers invariably receive on visiting the city of Bristol, is the prevalent dirty condition of the streets and public walks. The dirty approaches to the city from the railway termini and the narrow crowded state of the principal thoroughfares, some of which are perfectly inadequate to take the streams of vehicles, and are often so blocked up that no traffic can pass. These are also lined by houses inhabited by the tradesmen and artificers of the city. Some of these thoroughfares are so narrow that it is possible to converse freely across the street from window to window, and in some portions even to shake hands easily from one side to the other out of opposite windows. These streets have not been altered since the days when all the traffic was conducted on pack-horses and mules.

Hence overcrowding of the population everywhere exists; small houses for working-men are scarcely to be met with, and lodgings are also over-filled. Children everywhere swarm the roads, alleys, and public squares; whilst the prevalence of low habits of intoxication amongst almost all classes of society adds fearfully to the illness of the population. Delirium tremens, jaundice, dropsy, Bright's disease, and various forms of mania prevail as the results of these fearful breaches of social morality.

A large and commodious lunatic asylum has already become over-filled, as the consequence of this prevalent source of lunacy, pauperism, and crime.

What the Liverpool and Leeds Canal is to Liverpool, and the Froome to Bristol, that the river Clyde is even, in a greater degree than either, to *Glasgow*—the magnificent city to which it should bring health as well as wealth—an open sewer, breeding disease and abetting death in the havoc which he commits amongst its population. But when we say that the Clyde is a more serious danger to Glasgow than similar receptacles of filth are to other large towns, it is not intended as a condemnation of those who have the guardianship of the public health in that city.

Until about four years ago, the Health Authorities of Glasgow scarcely had any real or defined existence; since then, however, there has been a very marked change for the better. The Police Board, consisting of one of the three Town Councillors from each of the sixteen municipal wards, may be said to be the executive. It has for several years embraced a Sanitary Committee, the Chairman of which, Mr. Ure, has fortunately been a man of much energy and common sense, and is, besides, much respected. One of his first acts was to urge, successfully, the appointment of a medical officer of health, so that there should, at least, be some probability that any recommendations which he might make would be founded on scientific principles. Dr. W. T. Gairdner had then lately come from Edinburgh to fill the Chair of Medicine in the University, and as he had made a name for himself as a sanitary reformer by his lectures on "The Public Health of Towns," and had, moreover, expressed an intention of practising only as a consulting physician, thus having some time at his disposal, he was offered, and accepted, the appointment of chief officer of health for the city of Glasgow.

Five more medical men were appointed at the same time, each to take active superintendence of a district as its medical officer of health, but to act under the chief officer.

Various other officials are concerned in working out the sanitary arrangements determined on by the medical staff, or rather by Dr. Gairdner, with the approval of the Sanitary Committee of the Police Board. The chief superintendent and district superintendents of police have a certain amount of power in their hands, under the provisions of the Glasgow Police Act They can order outside cleansing, such as in common stairs, closes, courts, lanes, together with the removal of nuisances; and they can prosecute before the police magistrates if their orders are not attended to. The city architect, who is superintendent of streets and buildings, is also concerned in the work, being consulted both by the medical and police staffs, and is the professional inspector in various matters incidental to the health of the town.

Thanks to the activity of the Chairman of the Sanitary Committee, and to the special qualifications which Dr. Gairdner has for the performance of the duties devolving on him, the sanitary arrangements of Glasgow are tolerably good. Nor is it the fault of the assistant officers if there is anything to complain of there on the score of public health. There, as elsewhere, *overcrowding* is found to be one of the most productive causes of epidemic diseases, and to keep this down the Police Act (1862) requires, in all houses of less than three apartments, an absolute minimum of 300 cubic feet of space for each person above eight years, and of 150 cubic feet for each person under that age, inhabiting the house. The law is enforced by the police through a particular system, indicated by tickets, and hence there are ticketed houses and others. In several sanitary districts of the city no houses at all have been ticketed; in others, very few; and in others, again, a moderate or very large proportion, according to considerations of public expediency.

So great has been the energy of the proper authorities that, in the 54 sanitary districts of the city, the following was the state of the ticketing system on the 31st January of this year:—

Houses overcrowded (that had been ticketed) . .		1,046
Containing individuals over 8 years . .	673	
„ „ under 8 „ . .	1,509	
		2,182
Not overcrowded		12,526
Empty houses		252

This is independent of the common lodging-houses according to the Act. They are not ticketed, but are under such regulations as practically prohibit overcrowding. Comparing the vital statistics of some of the sanitary districts in different years, and these again with the ticketing statistics, it is found that it is quite possible, by legal interference, to do a good deal towards mitigating some of the worst evils connected with over-population; and it is satisfactory to note that in districts in which overcrowding and epidemic fever were previously very great, indeed for a long series of years, the fever rate has persistently declined as the number of overcrowded houses has diminished. In other districts of the city, having much greater natural advantages of situation, and a much superior class of population, the increase of epidemic fever has kept pace with the overcrowding of the ticketed houses which has been permitted.

Glasgow is provided with water-closets to an extent that is quite unusual in large towns. In houses built within the last fifteen or twenty years, it is a very common thing to find one to each family inhabiting a house of three or even two apartments. As these all communicate with the Clyde by means of the sewerage, a large proportion of the fœcal matter finds its way into the river, no small part of which has actually to mix with the water of the harbour. The condition of the harbour for some years has, in consequence, been foul and noxious in the extreme.

Besides the water-closets, there are in Glasgow 122 public and 3,131 private conveniences. The first named are large iron structures, situated in various parts of the town, especially in the vicinity of the harbour, and in places of great public resort, as the Glasgow Green and the Parks. The private conveniences, to each of which twelve families, on an average, claim access (!) are situated in the back courts attached to the houses in the less respectable parts of the town. They communicate with the ash-pits or middens. Under ordinary circumstances, these privies and middens are said to be emptied frequently, always before they become inconveniently filled, and always at the depth of night. The contents are carted to one or other of several large public manure depôts on the outskirts of the city, either close to, or in the vicinity of, some railway line. From these depôts the manure is removed, at the expense of farmers who purchase it, by carts or railway waggons, into the country. When any particular spot is the seat of epidemic disease, the middens are immediately cleaned out, and the dungsteads are disinfected by chloride of lime, or chloride of zinc (Sir Wm. Burnett's disinfecting fluid). Carbolic acid and Condy's fluid are being tried just now. As far as it is possible to do so, the Glasgow authorities guard against the ill-effects of old-fashioned public and private conveniences and manure depôts, within or near the limits of boroughs; but they are infamous relics of a barbarous age; they are a disgrace to civilization; and no reasoning, no ameliorating action justifies their continuance.

The courts are thoroughly washed with water delivered by a hose, and it may be that the common stair is whitewashed with caustic lime. If the subjects of the epidemic disease, as fever or diarrhœa, be poor, it is very probable that the medical officer will order admission to the hospital lately erected, in a case of emergency, by the Police Board, because of the difficulty of obtaining admission for such patients into the fever hospital at the Royal Infirmary. The house where the disease existed is then taken possession of by the sanitary department; the bed and body clothes are taken away, and thoroughly washed, and dried at a high temperature; the straw is also taken away and burned; and the house is fumigated and disinfected by means of chloride of lime and sulphuric acid. After the house is whitewashed and otherwise cleansed, the bed is supplied with fresh straw, and the clothes are returned. It may here be mentioned that the medical officers have power, under the new Police Act (1866), to enter suspected houses during an epidemic period, and inspect the sanitary arrangements, and if a condition of things exists that is favourable to the spread of disease, they can order renovating measures to be performed forthwith at the expense of the landlord. This liberty is not granted to the police officers, as in their hands it would be liable to be abused. It should also be mentioned that, for the proper working of the sanitary scheme, which is only now beginning to get into shape, each district medical officer has under him a person to whom is deputed a good deal of the house visiting. He is expected to be a person of some discretion and good sense, and *must have had typhus fever*. He should call daily on his superior to report and receive his orders. The medical officer is guided very much in his inquiries by the death entries which the Registrar for the district supplies to him daily. If he finds deaths registered from houses in suspected localities, and from no assigned cause, or from some epidemic disorder, as small-pox, scarlet, typhus, or typhoid fever, or diarrhœal diseases, measles, &c., his subordinate officer visits them immediately, prosecuting his inquiries, and, if need be, he calls in the services of the cleansing officials. It is not erring much, if at all, to say that the whole power of the police establishment is at the command of the medical officers of health to keep disease in check.

The foul condition of the river Clyde is undoubtedly the chief nuisance in Glasgow. It could be abated or entirely removed if the sewerage were entrapped and carried away from the city, as it might easily be, by special channels; but public opinion is scarcely ripe yet for that very radical measure, and zealous as the authorities are for sanitary reform, this is rather too great a leap for them to take. The authorities are disposed to wait a little, so as to see what result attends the London movement with respect to the Thames, before launching into any operations that would involve a great outlay of money. With all their zeal, they have not yet learned to appreciate the value of human life. There are, likewise, various chemical works engaged in the production of nuisances. The chief of these is the famous establishment of the Messrs. Tennant, at St. Rollox, in the north quarter. Alkali, bleaching-powder, soap, acids, &c., are made in it in immense quantities, and the sewage from it emits a horrible stench of sulphuretted hydrogen on meeting the liquid town sewage in its course to the river.* The "Alkali Act," in the hands of Dr. Angus Smith, the Inspector, has been of some service in lessening the offensive character of the districts where the chemical works "most do congregate."

Whatever may be the hidden subtle influence which generates typhus, cholera, and such epidemic diseases, it is well known, from experience gained in Glasgow, that the condition of the dwelling-place and the condition of the body are intimately connected with the spread of disease. Overcrowding, bad ventilation, damp, darkness, and underground situation of dwellings, filthiness of the person, house, and places adjoining, are all conducive to the spread, if not to the origin, of epidemics. With this fact patent to them the municipal authorities sought, and have just succeeded in gaining, Parliamentary powers for carrying out a City Improvement Scheme, by means of which old houses in densely-peopled parts of the city will be razed to the ground, the lines of streets widened and straightened, and new streets formed where none have hitherto been. The purchase of the property required for these alterations will necessitate an enormous expenditure of money by the Corporation; but the citizens are wisely prepared to submit to an extra amount of taxation for a number of years, in the hope that the public health and the moral and physical condition of the people may be improved in a corresponding degree. The alterations in question will be effected where they are most needed, where disease, crime, and human wretchedness have for many years reigned supreme, and have continually shocked the moral sense of the well-to-do and better-disposed members of the community. By-and-by the mortality from epidemic disease will doubtless be much diminished when those improvements shall have been effected in Glasgow. A large portion of the excess of mortality is due to an unusually large infantile mortality; and the causes of death are in very many cases not registered, owing to the fact that medical men have not attended the patients during the fatal illness.

The mortality in Glasgow for 1865, as given by the Registrar-General, is 32·89, the number of deaths being about 14,000. Of these 3,166 are said to have been under 1 year of age, and 3,285 under 5 years!

These are sad facts. However, great praise is due to Glasgow for its energy in sanitary Reform, and no greater tribute could have been paid to its inhabitants than the mere mention by the Right

* It is but justice to say that the Messrs. Tennant have been at great expense to deodorize their liquid refuse, or rather to render it innocuous while passing through the town, for at first it is comparatively inodorous. They have had the professional services of eminent chemists, and they have constructed, at their own expense, a large sewer all the way from their works to the river, where the refuse is discharged.

Hon. H. A. Bruce, in his advocacy of his excellent Public Health Bill, of the circumstance that the city had voted over a million and a quarter for the purpose of rebuilding its courts and wynds!

Honour to Glasgow for its beneficent care for its defenceless and misguided poor!

Excepting the filthy condition of the Clyde, and the evils already referred to, there is little to be noted in the way of nuisances in Glasgow. The authorities, through the Sanitary Committee and Medical Officers of Health, are a-head of the ratepayers. The former scarcely need any stimulus from the latter. The inspectors of police and the Sanitary inspectors are about as lynx-eyed and keen-scented as it is desirable they should be, and they readily find out any external nuisances, that is, external to the places of abode. Anything that may escape the inspectors is most likely to be discovered by some indignant ratepayer, who forthwith makes his complaint publicly known. This is generally through the medium of the press, for in Glasgow they are a great newspaper-reading people. The complaint thus reaches the notice of the authorities, and if it is really a grievance, it is very soon remedied.

It is well to find such a facile mode of rectifying the abuses, or exposing the neglect of the Sanitary Authorities, but what we have said of Glasgow is unfortunately rather the exception than the rule, and the large and important town of *Leeds*, to which we shall now direct the attention of our readers, whilst it possesses one of the most influential Journals in the country, suffers under a sanitary executive of a totally different character; impressible only by the most energetic external action. The health of Leeds is supposed to be protected by the Town Council, whilst really what little is done in that direction emanates from the Board of Guardians, who are entrusted with the carrying out of the Diseases Prevention Act, and who usually proceed with tolerable vigour in periods of emergency. Probably they would have done more good for the town, had they not received a caution from the Privy Council last year, that they were acting beyond the law, and since that time they have confined themselves to their functions as a vestry.

But what shall we say of the Town Council, which through its Nuisance Committee, and Streets and Sewerage Committee, is supposed to be the sanitary executive in the borough?

There are upon these Committees, some individuals who are anxious to do what is right; but there, as in some other large towns, local "politics" form the active agent in the election of councillors, and the result is that knowledge, judgment, and modesty are supplanted by qualities of an opposite character.

The town is in a most discreditable condition as regards its back-lanes and alleys; the absence of connection between its houses and main sewers; its "becks," which are open and full of abominations.

The sanitary affairs of the town are supposed to be regulated by three Acts of Parliament, to which may now be added the much needed Sanitary Act of 1866. The last local Improvement Act gave power to appoint a medical officer, to provide open spaces for recreation, which are much needed in Leeds, to open out new streets, and to effect numerous other improvements.

The water-supply is very unsatisfactory. It is pumped up from the river Wharfe into large reservoirs and thence distributed to Leeds, but is contaminated by the drainage of Otley and other small neighbouring towns. Although it is well filtered and does not show much impurity on analysis, the public feeling is very strong against it, and steps are being taken to draw a supply from other sources.

Leeds suffers in a marked degree from all the nuisances with which our large towns are infested, to wit: Cellar dwellings; overcrowding, which has subjected it to serious outbreaks of typhus; insufficient conveniences, in same cases situated under the bedrooms; in other cases, twenty to thirty families use one convenience! And in others again, they have none at all! This is a wide-spread and repulsive evil in Leeds, demoralizing to the mind and injurious to the body.

The "becks" are miniature Clydes, but of course much more dangerous, containing dead dogs and refuse; and the river is also contaminated with the refuse of human beings and manufactories. The outlet of the sewage below the town is a shocking place; there the Cattle Plague commenced and there it obstinately continued.

Then there are "back to back" houses in great numbers; insufficient trapping of sewers, for want of water in dry weather, and the traps are generally choked up and useless. The sewers are imperfectly flushed, indeed it is a question whether they are ever flushed at all. Pigs are kept in large numbers in the town; the boiling down of fat, offal, &c., is also carried on within the boundary.

There is, as already stated, a great want of open places; many closed streets, alleys, squares, and *cul-de-sacs* need to be broken through, to provide circulation for the air, which does not now exist. The ashpits are inefficiently cleared; a large ashpit will sometimes be allowed to accumulate for six months or longer. The cleansing of the pavements is greatly neglected. Many houses, not cellars, are quite unfit for habitation, and those are often very much overcrowded with Irish. The lodging-houses are pretty well looked after; not so the public-houses and abodes of ill-fame. The supply of meat is insufficiently overlooked. Much very bad meat finds its way into the markets, which is said to pass muster on account of its appearance, whilst it has been found on the post-mortem examination of the animals to show evidences of disease.

A shocking cause of mortality in Leeds, another phase indeed of the same which exists in many of our large towns, is maternal neglect. In London, Liverpool, Manchester, and Glasgow there is a kind of legalized infanticide called "overlaying," where the mother gets drunk and smothers her child by lying down upon it in bed. In Leeds they are not quite so bad (although no doubt that accomplishment exists also); the mothers at work in the mills entrust their children to old women who feed them improperly and drug them to keep them quiet, which they do effectively.

Mr. Darnton Lupton, the ex-Mayor, has done much good through the establishment of a Working Man's Club; Dr. Allbutt has started a Labourer's Dwelling Company, Limited, and they have a Sanitary Association. A private individual, too, lately prosecuted the Corporation and compelled them to close their manure depôts, which until recently were fruitful sources of disease; and from this account of the state of the town, we think our readers will agree with us, that the Association has a wide scope for the exercise of its functions.

Hitherto we have had to deal rather with sins of omission than of commission on the part of our municipal bodies, but when we come to deal with the sanitary condition of the metropolis of the north of England, *Manchester*, we find a state of things calculated to make Englishmen blush with shame.

The health authorities of Manchester are the Town Council, and this body numbers amongst its members many kind, well-meaning, earnest men, who would like to see a radical reform in its mode of dealing with sanitary matters. There is a monthly visiting Committee, which inspects courts, alleys, and cellars, debates on their condition, and proposes action; but still a state of things exists—in fact an association of all the monstrous abuses to which we have referred in dealing with other towns—which horrifies tyros in the Council, and chokes their utterance; and so the world does not get to hear of the true causes of the unhealthiness which confers upon Manchester the second place in the mortality scale of our large towns.

No doubt the authorities will find apologists. They are kind to their equals, don't annoy their friends, and they are afraid of running the town into debt; so they save the money and sacrifice the lives of the ratepayers. Of course the dead cannot complain, and the burdens of the living are comparatively light. It is even whispered that the Corporation drive a lucrative trade in the refuse of the town, earning thousands by it. How can anyone be cross with such excellent political economists?

The mode in which they conduct their gigantic manure manufactory is as follows:—They have four manure depôts, *all within the city*. One in Water Street, two at the Railways. and one at

New Allen Street, and their manufacturing business is carried on partly in the streets of the town, at the houses in fact, and partly at these depôts. The nightmen pick over the contents of the ashpits when they empty them, wisely distinguishing between "rubbish" and "manure." The latter is conveyed to the depôts, the former is tipped *somewhere, anywhere* where it is permitted. Arrived at the depôts, the second stage of manufacture is performed. At one depôt slaughter-house refuse is mixed with it, and the stench there is perhaps as horrible as any that can be conceived on the face of this otherwise fair earth! The street-sweepings are also sorted. From certain streets (those paved with square-sets) they rank as "manure," which is stored, whilst that from macadamized streets is "rubbish," and is got rid of *somehow*. In order that the Corporation may carry on their business more snugly, they have purchased property about the depôts, so there is no chance of their own nuisance inspector finding them out and troubling them with summonses. As we have said, they drive a great trade. They have their travellers out on the main lines of railway and one in Cheshire who sell "on commission," and send home plenty of orders. Should the admiration of our readers for the Manchester Town Council make them anxious to have a transaction with them, we may mention that their dry manure may be purchased at 1*s*. 9*d*. and their wet at 1*s*. 3*d*. per cubic yard.

There are just sufficient water-closets in Manchester to pollute the water-courses, but not enough to make it worth the while of the Council to embark in a new line of business and sell the sewage. The rivers and canals are as fertile sources of disease as any of the other open sewers to which we have referred.

In many parts of the town the same deficiency of conveniences exists as in the other large towns, and the inhabitants are thus taught the filthy habits upon which they are afterwards lectured. There, as it might be expected, the smoke nuisance is very great, and adds to those already referred to. There are acres of houses which should be pulled down; badly-built cottages, where overcrowding is added to bad ventilation. A large proportion of the lower classes is, of course, as much addicted to drink there as elsewhere, and as they earn high wages, they have greater facilities for indulging in debauchery. In many cases their pleasures are unworthy of the name, and their money is squandered in momentary indulgences, whilst their houses are pig-styes and their families half-naked. Mr. Edward Brotherton we believe it is who states that education has retrograded in Manchester, and upon its decline a crowd of evils has arisen.

Of course we are not now condemning the whole labouring class; and if we were dealing with the other side of the question we should be able to adduce much that is noble and creditable. But one thing is certain—lectures on Sanitary Science are worse than meaningless, and denunciations of filth, overcrowding, and drunkenness, rank hypocrisy, whilst the authorities themselves are the chief offenders against propriety, and, as in Manchester, consciously and obstinately so.

Whilst the Sanitary Act, 1866, was passing through Committee, private individuals were prosecuting and pressing the authorities of Leeds and Liverpool very hard, and they knew that as soon as the Act was passed appeals to the Home Secretary might be made against them ; but the Leeds Town Council allowed the Bill to take its course, whilst that of Liverpool, through one of the Hon. Members for the Borough, expressed its cordial approval of the measure. But what did the Manchester authorities do?

One of the clauses of the Bill empowered private individuals to summon Nuisance Authorities before the magistrates if they failed in the performance of their duty; and, will our readers believe it? the Manchester Council formed a powerful coalition with other neighbouring municipal bodies and with persons in the House of Commons, who they thought would, through the political necessities of the Conservative Government, prove useful allies, and they sent a deputation to the Home Secretary to induce him, if possible, to withdraw this clause. They succeeded so far as to obtain a modification of it, the final appeal being now transferred to the Home Secretary! In a recent case, however, when an appeal was made to the Home Secretary to compel the authorities of Liverpool to discontinue a nuisance, he stated that recourse must *first* be had to the local magistrates, and his authority invoked only as a final appeal, so the Manchester gentlemen have succeeded in rendering the previously existing law more stringent and effective.

We doubt very much whether the good old town knows of these things, for the proceeding was very quietly conducted; if not, it will now be aware of the character of the "guardians of its health."

Before passing away from the consideration of the sanitary management of particular towns to the more general question of the means to be applied for enforcing reform, we would say a few words concerning mortality tables. The question of mortality must not be regarded in a partial manner, and it cannot yet be comprehensively considered. Outbreaks of some particular disease in one town will often exhibit its mortality rate to disadvantage for a time, and when the atmosphere is relieved, it may for a while appear to greater advantage than its sanitary condition would justify. For example, the death-rate of Bristol for the week ending March 17, 1866, was 40, that of Manchester 39. But Bristol was suffering from an attack of typhus, and for the whole year 1865, the death-rate of Bristol was 23·52, whilst in Manchester the rate of mortality was 33·01 in 1,000! Again, the mortality rate of Hull in 1851 was 36, whilst in July, 1866, when the death-rate of London was 22, that of Hull was only 18. But the average of Hull is higher than that of London, as will be seen in the table below.

It is impossible at present to form more than a partial acquaintance with the rates of mortality in the large towns, as it is only recently that the registration has been placed on a satisfactory footing. Such as it is, however, it has enabled us with the aid of information kindly given to us by the Registrar General, to draw up the following table, indicating the relative sanitary changes in some of our large towns. The average annual mortality for each of the large towns named (excepting London) was correctly ascertained for the first time in 1865; and the mortality of those towns in 1851 is that of the registration districts in which they are situated. The last column shows the mortality when it was unusually high.

RATE OF MORTALITY TO 1,000 LIVING.

Towns.	Annual Average in 1851.	Annual Average in 1865.	Week ending March 17, 1866.
Bristol . . .	28	23·52	40
London . . .	24·44	23·39	30
Hull	25	27·27	34
Edinburgh . .	?	28·10	38
Leeds	28	30·95	38
Glasgow . . .	?	32·89	35
Manchester . .	31	33·01	39
Liverpool . . .	33	36·42	57

If it were quite fair to draw inferences from this table, it would appear that every town excepting Bristol and London has been becoming gradually more unhealthy; and we should be disposed to place great reliance even upon these imperfect data (for there is no doubt that that has been the tendency in our large towns), were it not for the apparent exception in favour of Bristol. The statistics of that city show that where insalubrious conditions exist (as they undoubtedly do there), as soon as an unhealthy season presents itself, the hand of disease grasps such a place, and the sanitary thermometer flies up almost to a level with the worst town in the kingdom. The causes are obvious; overcrowding, drunkenness, accumulations of filth, improper modes of disposing of the night-soil, imperfect conveniences at once tell their tale, and death stamps the vicious and neglected cities with his brand.

But the remedy for all this negligence, sin, and corruption is now at hand, and if the *Sanitary Act*, 1866, be not rigidly enforced, either by Corporations, Societies, or private individuals, then the people of this country will richly deserve the severest calamities that can befall them. Hitherto they have had the justification of ignorance; now that is withdrawn from them, and the neglect of sanitary precautions becomes unpardonable.

The new Bill contains, briefly stated, the following provisions:

It enables "Sewer Authorities" to form themselves into Committees and to avail themselves of the assistance of ratepayers, by adding intelligent professional or other citizens to their number; to form special drainage districts for the purposes of the Sewage Utilization Act, and to collect the needful rate in such districts. It gives greater facilities for connecting outlying places with main sewers: Provides powers for the authorities to obtain a proper water supply.

With regard to nuisances: If the Nuisance Authority fail to discharge its duty, it gives power to the Home Secretary to employ the Chief Officer of Police, to "institute any proceeding which the nuisance authority of such place might institute with respect to the removal of nuisances."

It enables any ten inhabitants of a place to compel the removal of a nuisance, by a requisition to the authorities; with the same effect as would a certificate from the Medical Officer of Health.

It defines nuisances; overcrowded houses, factories, bakehouses which are uncleanly or so ill-ventilated as to render gases, vapours, dust or other impurities generated therein dangerous to health, or which are overcrowded. Smoky chimneys.

It defines the duties of "Nuisance Authorities." They must make periodical inspections for the purpose of enforcing the Act, must compel owners or occupiers of houses to cleanse and disinfect them and any articles they may contain, "*upon the certificate of any legally qualified practitioner*" that such cleansing and disinfection will tend to prevent or check infectious or contagious disease, and the Act gives them summary powers in case of the default of parties refusing to cleanse. It enables them to provide hospitals, houses for the disinfection of bedding, &c. &c., carriages for persons suffering from infectious diseases. To remove to the hospital (with the consent of the superintending body) persons suffering from dangerous infectious or contagious diseases. It makes it incumbent upon the authorities to remove and bury dead bodies.* It enables them to erect mortuaries for the reception of bodies to be subjected to post-mortem examination, and gives other powers and instructions on the same subject.

The Act further authorizes "Nuisance Authorities," with the

* Cases are not uncommon where the relatives of persons who have died of infectious or contagious disease, insist upon retaining the body in the house to the danger of their neighbours' lives.

previous sanction of the Secretary of State, to fix the number of persons "who may occupy a house or part of a house which is let in lodgings." To register houses thus let; to inspect them and enforce cleanliness; to enforce "the Provision of necessary accommodation in proportion to the number of lodgings and occupiers; the cleansing and ventilation of common passages and staircases;" "the cleansing and lime whiting at stated times of such premises." Where two convictions have taken place for breaches of the Act, within three months, the authorities may permanently close the unhealthy house.

The Act provides for the disinfection of carriages in which infected patients have been conveyed; and (by heavy penalties) against the exposure of themselves, by persons suffering from infectious diseases,* or of infected clothing, bedding, &c. &c.

It contains provisions to prevent the letting of a house or any portion of it, in which a dangerous infectious disorder has been, without its having been previously disinfected to the satisfaction of a qualified medical man; and, "for the purposes of this section, the keeper of an inn shall be deemed to let part of a house to any person admitted as guest at such inn." The penalty in this case is 20*l*. In cases of divided authority (as at Bristol, Leeds, &c.), the Privy Council may cause the Boards to act together, and may prescribe the mode of such joint action. The Act also provides summary and effective means for enforcing the periodical removal of manure and refuse matter from stables, mews, &c., upon a public notice being given; the penalty being twenty shillings per day, for every day the accumulation is allowed to remain beyond the specified time.

And finally, it contains stringent provisions for compelling the authorities themselves to perform their duty. Where a complaint is made to the Secretary of State, that any authorities have neglected their duty, either in regard to sewerage, water-supply, or removal of nuisances, he is empowered, "if satisfied after due inquiry made by him that the authority has been guilty of the alleged default," to make an order limiting a time for the performance of its duty in the matter of such complaint; and if they still fail to perform their duty, he may appoint some one to do it for them, and make them pay the expenses thus incurred, "together with the costs of the proceedings."

Having thus summarised the contents of the Act which affects the houses, habits, health, and comforts of almost every family in England, we would in conclusion say a word to our readers in regard to its application.

It is perfectly obvious that its usefulness will depend largely

* A shocking case of this kind is mentioned in our article on the "Predisposing Causes of Pestilence:" 'Journal of Science,' July, 1865, p. 388.

upon the action of the local authorities; and in case of default on their part, then its operation will have to be promoted by private individuals and sanitary associations, which should be at once formed wherever they do not already exist.

If we could be certain that Town Councils, Boards of Health, and other Local Authorities, would regard the Act as the herald of sanitary reform; would promptly, wisely, and unflinchingly give effect to its clauses, then nothing further need be said on the subject. But the experience of the past has taught us to expect different results; in fact the clauses directed against defaulting Authorities sufficiently indicate the views of the Legislature in that respect.

Much will therefore depend upon those watchful, self-denying men whose business it is to prescribe for the sick, whether in body or mind, upon medical men, ministers, and district visitors; and the first-named, especially, are now provided with a ready means of enforcing cleanly habits amongst their poorer patients. We advise all such persons to obtain a copy of the Act,* to peruse it carefully, and to do all that lies in their power to compel obedience to its provisions. Let them not be afraid of offending local authorities; they will find the Home Secretary prompt in responding to complaints, where the authorities are neglectful of their duty. Let them urge their wealthy and better educated parishioners and patients to take up the cry of sanitary reform; and let those also bring their means and energy to bear in the good cause.

If local authorities are desirous to avail themselves of the Act, let them not be over-confident. It seldom happens that they have amongst them scientific men able to guide them, but there are in every town intelligent professional men, who, although they may be retiring, and may have a distaste for municipal politics, will gladly give their advice and assistance to the Council of Health; and thus will be obviated those pitiful exhibitions of ignorance with which the world is sometimes astonished, and which have the effect of handing over the poorer classes to the mercy of quacks and pretenders ever watchful for their prey.

In all large towns it will be absolutely necessary to build healthy houses for the poor, who will be turned out of their wretched habitations by this Act; and in such towns it generally happens that the charities are maintained, and the philanthropic undertakings fostered by a very small proportion of the inhabitants. May these lines be read by some of those whose thoughts have not yet travelled into the realms of sympathy for the poor, and may they too give their aid and counsel in the good cause!

There is no apology necessary for the large amount of space which has been devoted to this subject; nor need we make excuses for the repulsive details which we have been compelled to notice.

* 'The Sanitary Act, 1866.'

It is not our fault that they exist, but being in existence it has been our duty to expose them. We fervently hope that the visitation from Above, and the legislation of man, may have the effect, once for all, of sweeping from amongst us the nuisances and unhealthy conditions which decimate our large towns; and may they inculcate lessons of morality, sobriety, and cleanliness in the minds of the people.

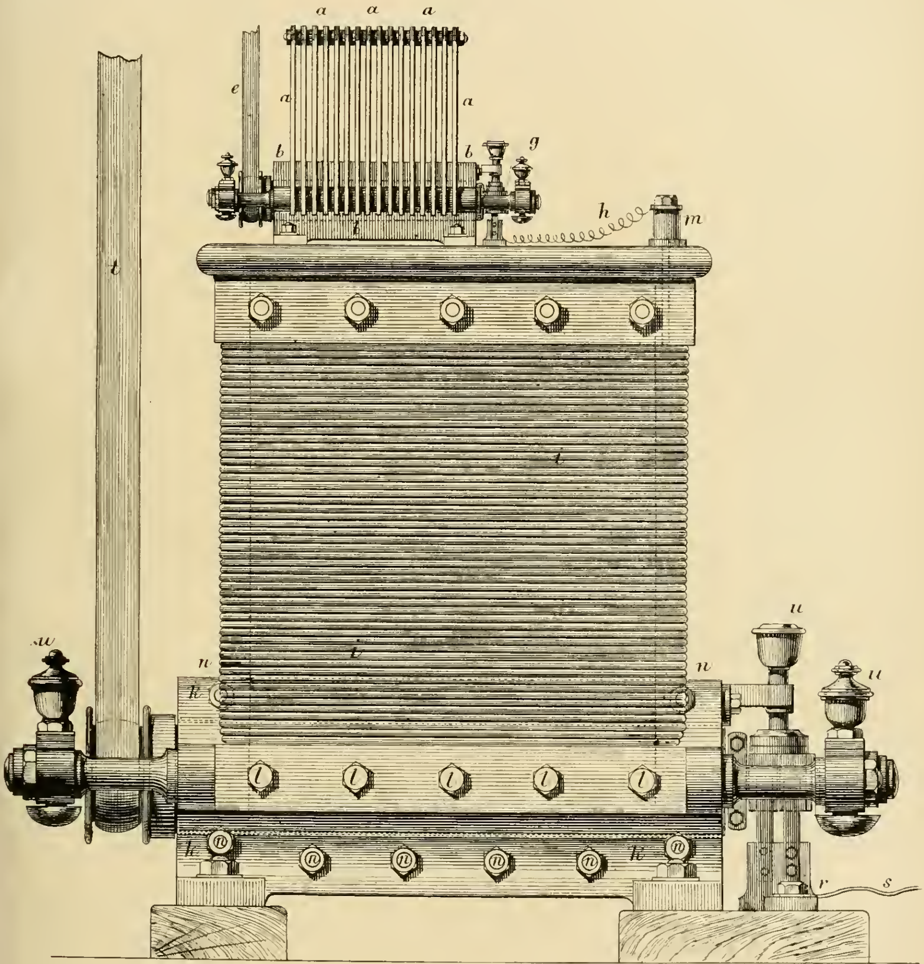
III. A NEW ERA IN ILLUMINATION.—WILDE'S MAGNETO-ELECTRIC MACHINE.

By William Crookes, F.R.S.

In the first number of this Journal an article "On Lighthouse Illumination by Magneto-electricity," was contributed by Dr. Gladstone. Nearly three years have elapsed since that time, and a very important result in this branch of Science having recently been obtained, it seems a fitting opportunity again to draw attention to the subject, as an introduction to our more immediate topic.

The experience of the last two or three years in the use of the electric spark in lighthouses has brought prominently forward several disadvantages and objections under which it labours. The advantages are many and obvious, and were well summarised in Dr. Gladstone's article, and were amply sufficient to justify the English Authorities in persevering attempts to introduce this light into practice. In 1855, while corresponding on this subject with the late Hydrographer to the Admiralty, Admiral Washington, Mr. T. Stevenson stated, "What we want is powerful apparatus, not intricate distinctions. To be enabled to see a light in a thick night, though it be only half-a-mile further than at present, may be of incalculable moment. If therefore we can increase the power of our lights so as to make them pierce the gloom but that fraction of a mile further than they do at present, we are moving in the right direction. On that small amount of extra offing, hundreds of lives may depend." It would appear as if the electric light was pre-eminently adapted to meet a case like this; but, recently, doubts have been thrown on its superiority over oil in penetrating fog. In 1865, Mr. Berthon, the Secretary to the Trinity House, said, that, for a limited range of from nine to ten miles, the electric is immensely superior to any other light, but beyond that distance it appears to lose in a great degree its power, until at eighteen or twenty miles it is not very different to any ordinary first-class light; and Mr. Stevenson likewise states, that at great distances the oil light maintains its power better than the electric. Such a phenomenon certainly seems

Fig. 1.



F. C. Bosman lith

WILDE'S MAGNETO-ELECTRIC MACHINE.

to be very improbable, although it may be the case that the rays proceeding from the electric light suffer so much more from absorption in passing through an obstructive medium than those from a flame produced by the consumption of oil, as to leave the oil light the more powerful of the two at great distances. If this were really so, it would follow that the application of the electric spark to lighthouse illumination is based upon a fallacy. The mere glare or splendour of effect to a near observer, so far from being an advantage to the mariner, is a positive evil, because, by its lustre, it tends to destroy his powers of perception of objects in the water that are nearer his view, and which therefore, from their proximity, threaten more immediate danger to the safety of his vessel. All the mariner requires is distinct visibility. The really useful power is that of penetration through an obstructing medium, and, therefore, the true measure of the usefulness of any light, is the distance to which it remains distinctly visible, and at which it preserves its characteristic appearance. This objection to the electric light has only been made within the last year or so, and is apparently irreconcilable with the statements respecting its brilliant visibility at great distances, upon which so much stress was laid on its first introduction.

Other difficulties have also been met with. The kind of knowledge and attention required to render the magneto-electric light constant and sure is far above that necessary with the most elaborate oil lamp; and the uncertainty to which the use of machinery of any kind is inherently liable, independently of the necessity of maintaining a constant supply of water, and the great difficulty of repairing and renewing the steam-engines and magneto-electric machines when required, all contrast most unfavourably with the certainty and simplicity attending the present oil lamp system. To this must be added the constant difficulty experienced in maintaining a class of persons for so responsible an office as that of engineer or attendant. A lighthouse, from its special nature, its great importance, its uninterrupted action, and its isolated position, is, in the language of Dr. Faraday, the last place to which processes comparatively new in their nature should be applied, if there be any other educational positions which can precede such application. Now, in spite of all the care which the importance of the subject has rendered necessary, the Dungeness electric light entirely failed or was inefficient for upwards of 119½ hours, between August, 1863, and October, 1864; and referring to this, the Elder Brethren of the Trinity House say that it appears to them to be impossible to obtain entire immunity from such accidents, so long as human nature is subject to infirmity. These fallings off and cessations have frequently rendered it necessary that the ordinary oil lamps should be lighted, and notwithstanding the power of the magneto-electric light, instances have occurred of vessels being stranded near Dungeness. This liability to occasional failure is a matter for grave consideration in respect to the development of the magneto-electric light as an element of lighthouse illumination.

Under these circumstances the Elder Brethren stated on January the 18th, 1865, in answer to an inquiry from the Marine Department of the Board of Trade, that they are induced "to adhere to the opinion, expressed to their Lordships in their letter of the 8th April, 1863, that they are not prepared to recommend the adoption of the magneto-electric principle for lighthouse illumination." This opinion was repeated on the 15th of March, 1865, when the Secretary of the Trinity House wrote as follows:—

"There are numerous other causes of minor importance which have led the Elder Brethren to the decision expressed in my letter of the 18th January, which can only be duly weighed and appreciated by those on whom the responsibility of working, and, above all, of maintaining the lights is placed, and as already expressed in their letter of 8th April, 1863, the Elder Brethren feel that there are no advantages which can counterbalance the want of certainty in lighthouse illumination."

Meantime a somewhat modified system of illuminating lighthouses by electro-magnetic apparatus has been successfully exhibited at Havre, in France, and the Commissioners of Northern Lighthouses suggested that their engineer should be sent over to report upon it. It appeared that the plan adopted was very similar to that of Mr. Holmes, and that M. Berlioz had only made a few improvements upon it. Mr. Holmes being of opinion that he could now supply a better machine than the one in use at Havre, it was considered that it would be a national discredit and an act of injustice to that gentleman, if under these circumstances the foreign system were adopted. It was therefore decided at the latter end of last year that an entirely new system of apparatus, including lamp, machines, and engine, should be procured from Mr. Holmes; that the eminent optical engineer, Mr. James Chance, should be asked to put into practice certain opinions which he has always held respecting the size of the lens required, and the arrangement of curvature, he undertaking to supply an instrument which should be entirely suitable; whilst the Elder Brethren proposed to combine with this new apparatus a thoroughly independent system of management, which they trust may result in the establishment of the magneto-electric light as a useful component of lighthouse illumination.

Early in the present year, rumours of Mr. Wilde's new electro-magnetic apparatus were first heard, and Mr. Thomas Stevenson was instructed to visit Manchester to report on the same. He was so very favourably impressed with the apparatus, that it was considered indispensable to a proper series of experiments, that it should be tested along with Professor Holmes's. An estimate was accordingly obtained from Messrs. Wilde, and their offer was at once accepted.

The light from Messrs. Wilde'sl arge machine, which Mr. Stevenson saw, is the most powerful artificial light which has ever been produced, giving about eight times the light of the magneto-electric machines now in operation, and it was therefore not considered desirable to suggest the use at present of that sized machine for lighthouse purposes. A machine about half the power of the large one was recommended, as by a simple arrangement the brilliancy of the light, and the power required to drive the machine, could be varied at pleasure, to suit the different conditions of the atmosphere, and with it requirements could be met which would be beyond the power of any other description of machine. The dimensions of such a machine would be—length 64 inches, width 20 inches, height 48 inches, and the cost 1,000*l*. Ultimately a machine of half this power, to cost 500*l*., was decided upon, and when the writer had the pleasure of visiting Messrs. Wilde's workshops, and the advantage of listening to the inventor's lucid description of his large machine, the one being made for the Commissioners of Northern Lighthouses was far advanced towards completion.

Like most practical applications of science, the important results which Mr. Wilde has obtained, depend more upon an ingenious combination of several known facts, united with considerable engineering skill, than upon any really new and striking discovery in the science. The principle of the machine can be expressed in a few words. It consists in the application of the current from an electro-magnetic machine, armed with permanent magnets, for the purpose of exciting a powerful electro-magnet; this electro-magnet being now used as the basis of a still larger electro-magnetic machine, for the purpose of having induction currents generated by its agency. In other words; by well-known means, an electric current can be obtained by the rotation of an armature close to the poles of a magnet. If this electric current be passed round an electro-magnet, it may be made to produce a far greater amount of magnetism than was possessed by the first magnet. There is no difficulty, therefore, in comprehending how, by the mere interposition of a rotating armature, and the expenditure of force, a small and weak magnet may be made to actuate a very powerful magnet. But as the power of the magnet increases, so does the power increase of the electric current which may be generated by induction in an armature rotating between its poles. We have therefore only to pass this No. 2 induced current from No. 2 magnet round a still larger magnet No. 3, and by rotating an armature between its poles we can get a still more energetic induced current No. 3. Theoretically there is no limit to this plan; it is a species of involution; and when it is considered that each conversion from magnet No. 1

to Magnet 2, &c., or from induced current No. 1 to induced current No. 2, &c., multiplies the power very many times,* it will not be considered surprising that after three involutions the induced current possesses such magnificent powers.

Some erroneous opinions are pretty generally entertained as to the actual discovery claimed by Mr. Wilde, and the splendour of the result, for achieving which he deserves the very highest credit, is liable to cause earlier investigators in the field to be overlooked: this would be most unfair, for it is through their instrumentality that the way has been paved for the success now achieved. In 1838 the Abbés Moigno and Raillard† proved that by taking an electro-magnetic machine, the original magnet of which would only support a few grammes, and passing the electric current generated by it round a large electro-magnet, the latter could be made to support a weight of 600 kilogrammes. The Abbés carried the multiplication of power only so far as to obtain the more powerful magnet No. 2 from the weak magnet No. 1.

Electro-magnets of extraordinary power, with coils arranged longitudinally instead of transversely on their armatures, had been made by Mr. Joule. Magneto-electric machines with revolving armatures, in which electro-magnets had been substituted for permanent magnets, had been constructed by Dr. Page and Professor Wheatstone. Magneto-electric machines had been made to act on electro-magnets in various telegraphic instruments by Wheatstone, and subsequently by others; and Dr. Page, as well as the experimentalists above mentioned, had observed the important fact that an electro-magnet excited by a magneto-electric machine became capable of effects greatly exceeding those of the original magnet. The peculiarly constructed armature employed by Mr. Wilde is likewise essentially identical with Siemens' helix, a full description of which may be seen in Siemens' patent, and also in the fifth volume of Du Moncel's 'Applications de l'Electricité,' page 249, published in 1862. It is, however, right to say, that Mr. Wilde, in his patent of February 25, 1863, expressly states that he makes no claim to the peculiar construction of the armature.

By the kindness of Mr. Wilde we are enabled to give our readers a full description, with drawings, of the machine now in process of manufacture for the Northern lighthouse. Fig. 1 represents a side view, and Fig. 2 an end view of the machine; the letters referring to the same parts in each: *a a a a a* are 16 permanent magnets, bolted on to the magnet cylinder *b*, shown in magnified section at Fig. 3. The magnets weigh about 3 lbs. each, and will support a weight of about 20 lbs. In the magnet cylinder the part *b b* is

* We say very many, but we have absolutely no data to guide us to a near approximation.

† Moigno's 'Télégraphie Électrique,' p. 15. Paris, 1849.

Fig. 2.

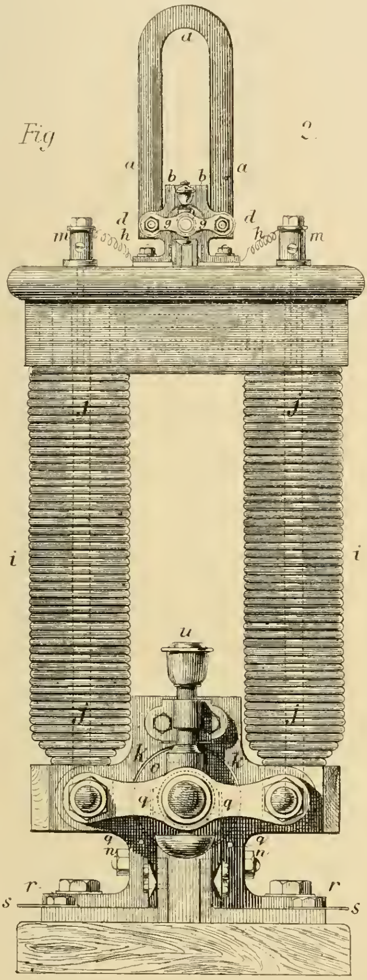


Fig. 3.

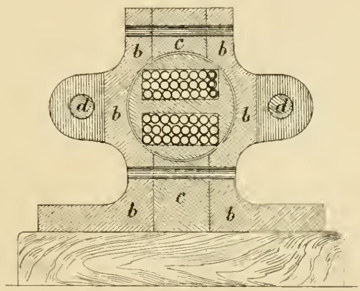
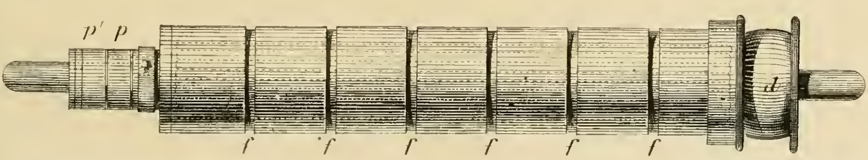


Fig. 4.



M & N Hanhart lith.

WILDE'S MAGNETO-ELECTRIC MACHINE

iron, and *c c* brass, and it is so arranged that *b b*, being screwed on to the respective poles of the magnets at *d*, form one entire north pole and one entire south pole to the 16 magnets, separated from each other by the brass pieces *c*. A circular hole, $2\frac{1}{2}$ inches in diameter, is bored lengthways through the metals, so as to form them into a hollow cylinder of brass and iron. Fig. 4 represents the armature; a transverse section of which is also shown in its place inside the hollow cylinder, Fig. 3. It consists of a cylinder of cast-iron, about one-twentieth of an inch less in diameter than the hole in the cylinder *b*, *c*, *b*, *c*, so that it may revolve in very close proximity to the interior of the hollow cylinder without touching it; being held at each end by appropriate brass supports, in which the axis of the cylinder works. At one end of the armature is a cylindrical prolongation *d*, on which a pulley *e* works, and at the other end is fixed a commutator. About fifty feet of insulated copper wire, one-eighth of an inch in diameter, are wound upon the armature in the direction of its length, as shown in Fig. 4, and in section in Fig. 3. The inner extremity of the wire is fixed in good metallic contact with the armature, the other end being connected with the insulated half of the commutator. Bands of sheet brass, *f f*, are bound at intervals round the armature, in grooves sunk in it for that purpose, their object being to prevent the convolutions of insulated wire from flying out of position by centrifugal force when in rapid rotation.

By means of the small strap *e*, the armature is made to revolve in the interior of the magnet-cylinder at about 2,500 revolutions per minute. During each revolution, two waves of electricity, moving in opposite directions, are induced in the insulated copper wire surrounding the armature. The rapid succession of alternating waves thus generated at the rate of 5,000 per minute are, by means of the commutator at *g*, converted into an intermittent current moving in one direction only, which is conducted along the wires *h*.

The electro-magnetic machine by which the light is produced is of precisely the same construction as the magneto-electric machine just described, except that an electro-magnet *i* is substituted for the permanent magnets *a*, *a*. The electro-magnet *i*, Figs. 1 and 2, is formed of two rectangular plates *j*, of rolled iron, 36 inches in length, 26 inches in width, and 1 inch in thickness, as shown by the dotted lines. They are bolted, parallel with each other, to the sides of the magnet cylinder *k* by means of the bolts *l*, and the plates are connected together at their upper extremities, by being bolted to a bridge formed of two thicknesses of the same iron as that of which the sides are made. All the component parts of the electro-magnet, requiring to be fitted together and to the magnet cylinder, are planed to a true surface, for the purpose of ensuring intimate metallic contact throughout the entire mass.

Each of the sides of the electro-magnet is coiled with an insulated conductor, consisting of a bundle of seven No. 10 copper wires, laid parallel to each other, and bound together with a double covering of linen tape. The length of conductor coiled round each side of the electro-magnet is 1,650 feet. Two of the extremities of the coils are connected together so as to form a continuous circuit 3,300 feet in length; the other extremities of the coils terminate in the two insulated metal studs *m m*, fixed upon the wooden top of the machine, and connected thereby with the wires *h h*. The total weight of the two coils of insulated copper wire, without the iron, is half-a-ton. The diameter of the hole in the magnet cylinder is 7 inches, and its length 35 inches. The separate parts of the cylinder are bolted together at the top and bottom by means of twelve copper bolts *n*, three-quarters of an inch in diameter. The armature *o*, which is an exact fac-simile, except as regards size, of the one already described, is about one-eighth of an inch less in diameter than the bore of the magnet cylinder. It is wound with an insulated strand of copper wire, 350 feet in length and a quarter of an inch in diameter, as shown in section in Fig. 3. A pulley *d*, 7 inches in diameter, is keyed upon one end of the armature, and upon the other end are fixed two hardened steel collars p, p^1, one of which is insulated from the armature axis. These form part of the commutator, by means of which the rapidly alternating currents are converted into an intermittent current moving in one direction only. These currents of electricity, which produce the light, are taken from the steel collars by means of the springs *q*, *q*, and thence to the screw nuts at *r*, from which they can be conveyed to any place required by the conductors *s s*.

The armature of the 7-inch machine is driven at 1,800 revolutions per minute by means of the strap *t*, from the same shaft as the magneto-electric machine. Reservoirs for oil are shown at *u*. The total weight of the machine complete is a little more than 1 ton.

The action of the machine will be readily comprehended from the explanation previously given. The electricity induced from the permanent magnets *a a a*, in the rotating armature of the small machine is transmitted, by means of the wires *h h*, through the coils of the large electro-magnet of the 7-inch machine, the iron plates and magnet cylinder of which acquire an enormous amount of magnetism. Simultaneously a proportionately larger amount of electricity is induced in the wires of the larger armature, and this current of electricity is used for producing the light. When the machine is in full action, an engine of about three-horse power will be required to drive it, and the lamp will consume sticks of carbon at least $\frac{3}{8}$-inch square. The power of the machine may be regulated according to the quantity of light required to suit the different conditions of the atmosphere, by placing small blocks of iron on the top of the small magnet cylinder *b b*, so as to connect the opposite poles, and proportionately diminish the power of the induced current in the armature.

This machine is, as already mentioned, considerably smaller than the one now in existence. In the former there are only two conversions, that is to say, a permanent magnet—an induced current of electricity—an electro-magnet—a more powerful induced current. In the large machine there is a still further multiplication of force. Its small magneto-electric machine has an armature of $1\frac{5}{8}$-inch diameter, armed with six small permanent magnets weighing 1 lb. each. The induced current from this is transmitted through the coils of the electro-magnet of a 5-inch * electro-magnetic machine, and the direct current from the latter is simultaneously, and in like manner, transmitted through the coils of the electro-magnet of a 10-inch machine. The weight of the electro-magnet of the 10-inch machine is nearly three tons, and the total weight of the instrument is about $4\frac{1}{2}$ tons. The machine is furnished with two armatures—one for the production of "intensity" and the other for the production of "quantity" effects. The intensity armature is coiled with an insulated conductor, consisting of a bundle of thirteen No. 11 copper wires, each 0·125 of an inch in diameter; the coil is 376 feet in length, and weighs 232 lbs. The quantity armature is enveloped with the folds of an insulated copper-plate conductor 67 feet in length, the weight of which is 344 lbs.

With the three armatures driven at a uniform velocity of 1,500 revolutions per minute, an amount of magnetic force is developed in the large electro-magnet far exceeding anything which has hitherto been produced, accompanied by the evolution of an amount of dynamic electricity from the quantity armature, so enormous as to melt pieces of cylindrical iron rod fifteen inches in length and fully one quarter of an inch in diameter, and pieces of copper wire of the same length and one-eighth of an inch in diameter. With this armature in, the physiological effects of the current can be borne without inconvenience; immediately after fifteen inches of iron bar had been melted, the writer grasped the terminals, one in each hand, and sustained the full force of the current. The shocks were certainly severe, but not inconveniently so.

When the intensity armature was placed in the 7-inch magnet cylinder, the electricity melted 7 feet of No. 16 iron wire, and made a length of 21 feet of the same wire red-hot. The illuminating power of the current from this armature was of the most splendid description. When an electric lamp, furnished with rods of gas carbon half-an-inch square, was placed at the top of a lofty building, the light

* For the sake of convenience, the different sized machines are distinguished by the calibre or bore of the magnet cylinders.

evolved from it was sufficient to cast the shadows of the flames of the street-lamps, a quarter-of-a-mile distant, upon the neighbouring walls. When viewed from that distance, the rays proceeding from the reflector have all the rich effulgence of sunshine. With the reflector removed from the lamp, the bare light is estimated to have an intensity equal to 4,000 wax candles. A piece of ordinary sensitized paper, such as is used for photographic printing, when exposed to the action of the light for twenty seconds, at a distance of 2 feet from the reflector, was darkened to the same degree, as a piece of the same sheet of paper was when exposed for a period of one minute to the direct rays of the sun at noon on a very clear day in the month of March. The day on which the writer saw the machine at work (towards the end of June), the mid-day sun was shining brightly in at the window. He took the opportunity of roughly comparing the intensity of the sun, with that of the electric light armed with the reflector. From a comparison of the shadows thrown by the same object, it appeared to him that the electric light had between three and four times the power of the sun light. That the relative intensities were somewhat in this ratio, was evident from the powerful scorching action the electric light had on the face, and the ease with which paper could be set on fire with a burning-glass introduced in the path of its rays.

The extraordinary calorific and illuminating powers of the 10-inch machine, are all the more remarkable from the fact that they have their origin in six small permanent magnets, weighing only 1 lb. each, and only capable at most of sustaining collectively a weight of 60 lbs. When working up to its full intensity, it requires an engine of about 7-horse power to drive it.

The physicist will, at first sight, consider that the intimate connection between the consumption of so large an amount of mechanical power, and the evolution of so enormous an electrical force, is a necessary consequence of the modern doctrine of the conservation of force. But, without for a moment denying the truth of this doctrine, it must be admitted that there are certain phenomena connected with this machine, which are in apparent contradiction to the law of conservation.

A phenomenon already obtained on a small scale by Jacobi, Lenz, and Miers, is rendered visible in the most striking manner by means of this machine. When the wires, forming the polar terminals of the small exciting magneto-electric machine, were connected for a short time with those of the large electro-magnet, and then disconnected, a bright spark could be obtained, from the wires of the electro-magnet, twenty-five seconds after all connection with the magneto-electric machine had been broken.

It will be of interest, apart from all questions as to economical production, to ascertain what is the theoretical quantity of coal required to be consumed in the production of this amount of electric force. Mr. Wilde says that a 7-horse power engine is required to drive the machine. One-horse power is equal to 1,980,000 foot-pounds per hour; that multiplied by seven is 13,860,000 foot-pounds per hour, which therefore represents the actual power required to drive the machine. Now, by multiplying the British Fahrenheit units of heat, produced by the combustion of one pound of coal, by Joule's equivalent, or 772 foot-pounds, the result will be the total heat of combustion expressed in foot-pounds. In the best coal this is as high as 12,000,000 foot-pounds. We arrive therefore at the startling conclusion, that, to overcome the friction of the different parts of the machine; to whirl a mass of metal, weighing several hundred-weights, round with a velocity of 1,500 revolutions per minute; to generate a current of electric force far surpassing anything ever before produced; and, after allowing for the waste inherent in its passage through the conducting wires and electric lamp, to cause it to blaze forth with an intensity of light, before which the rays of the sun himself appear pale and feeble; to keep up this intense development of energy for one hour, requires an expenditure of force represented by the combustion of less than $18\frac{1}{2}$ ounces of coal!

This is the theoretical calculation; but if reduced to actual practice, the results are scarcely less astonishing. The economy of the power actually employed by Mr. Wilde cannot be calculated, as the engine is a 60-horse one, and is used for driving the very heavy machinery of a wire mill, as well as performing the various operations required in an engineer's workshop; but the *efficiency* of an engine, *i. e.* the ratio of the work actually performed to the mechanical equivalent of the heat expended, is well known, and varies in extreme cases between the limits 0·02 and 0·2. Taking an average efficiency as 0·1, or one-tenth, we find that the ordinary consumption of coal required to work a 7-horse power engine, midway between excessive wastefulness on the one hand and rigid economy on the other, is $10 \times 18\frac{1}{2}$ ounces or $11\frac{1}{2}$ lbs. of coal per hour, worth about one halfpenny.

The above expense of one halfpenny per hour for coal is of course only one item in the cost,—to it must be added the expense of carbon rods for the lamp, which will be about ten inches per hour, worth perhaps a penny; there must also be added interest of the cost of purchase of machines, expense of maintenance and repairs, which will perhaps bring up the total expense per hour to sixpence or eightpence. Comparing this with the hourly expense of the electric lights already in existence we find, according to the Abbé Moigno, that the French machine costs altogether sixpence per hour for a light equal to 900 wax candles, whilst the actual working expenses of maintaining the electric light at Cape La Hève during a period of twenty-seven months have been, exclusive of salaries, about one shilling per hour, or inclusive of salaries, two shillings.*

According to a calculation made by the Abbé Moigno respecting the economy of the light evolved by the French machines, and altering the figures to suit the present case, it appears that to maintain a light equal to 4,000 wax candles for one hour, would cost, with gas, 1*l.* 2*s.* 6*d.*; with Colza oil, 1*l.* 7*s.*; and with the electricity produced by a Bunsen's pile, 1*l.* 15*s.* 6*d.*

The annual expenditure at a first-class lighthouse, on the old system, is on an average 400*l.* per annum, and on the assumption that the light burns for 4,000 hours per annum, that would come to two shillings per hour. The expenses of the old and the electric system are therefore not very dissimilar, and the problem of the adoption of electricity to supersede oil, must be decided on grounds of convenience and efficiency alone.

The great advantage of Mr. Wilde's over the old system of magneto-electric machine, appears to be that it is capable of amplification to any required power, by a mere enlargement of the size of the different parts. His largest machine weighs about three tons. If, instead of using the electric current generated by it to produce dynamic effects, we pass it round a still larger electro-magnet, we should at once produce a vastly greater development of force. The only limit which we see to this multiplication of power, is the excessive heat which would be developed in the rotating armatures. It would be an interesting problem to calculate what would be the result of driving the 32-inch armature, required for a 100-ton magnet, with (say) a 1,000-horse power steam-engine. If the power generated by this machine did not at once burn up the working parts, dissipate the electric lamp and conducting wires with a mighty explosion into space, and strike dead all the attendants with one lightning flash,—if it were at all manageable, and were put on a high tower, it would probably give light enough to make London by night considerably brighter than London by day.

Space will not admit of the enumeration of all the uses to which so convenient and economical a light may be applied. Moreover, this is a subject which has been so frequently discussed that any enumeration here would become a mere repetition. One practical application has however been made, which possesses great interest. Photographers are finding that it is more convenient than the sun. According to the 'Photographic News,' we learn that an establishment has been organized at Manchester, in which is fitted up the first of Mr. Wilde's machines for supplying the electric light. By the aid of this, more than two hundred negatives can be ex-

* 'Mémoire sur l'Éclairage et la Balisage des Côtes de France,' par M. L. Reynaud, p. 149. Paris, 1865.

posed in a day, to secure gelatine reliefs. This is the first practical application of the electric light to the commercial working of photography, its constancy rendering it here more valuable than an uncertain sunlight.

The purely scientific interest of this discovery has been scarcely touched upon. Of this more will be said hereafter. To physicists and experimentalists in magnetism the gigantic magnetic force developed in the three-ton magnet will afford an opportunity, which will doubtless at once be seized, of repeating and extending the classical researches of Dr. Faraday in Diamagnetism and the Magnetic Condition of all Matter.

IV. ADAMS' RECENT ASTRONOMICAL DISCOVERY.

By Richard A. Proctor, B.A., F.R.A.S.

If our earth, like the three other planets revolving within the zone of asteroids, had been without a satellite, mankind would in all probability have remained for ever in ignorance of the great yet simple law of universal gravitation. *Now*, indeed, that the discovery of the law has led to such vast progress in observational astronomy, and to so great an extension of the methods of infinitesimal analysis which alone enable mathematicians to deal successfully with the profound problems of physical astronomy, we know that the motions of the planets afford available and sufficient means of testing and establishing the theory of gravitation. But even to Newton's gigantic intellect the task of *founding* the theory upon such evidence alone would have been too vast. Conscious of this, we find him again and again impressing upon Flamstead the necessity of supplying him with lunar observations sufficient in number and accuracy to afford the necessary evidence in favour of the theory he wished to establish.

And as the moon afforded such important assistance when the theory of gravitation was first founded, so a careful comparison of the lunar movements with those which result from theoretical considerations has led to many valuable discoveries. Our determinations of the most important astronomical elements, *viz.* the magnitude, mass, and figure of the earth, and its distance from the sun and moon—"elements," says Laplace, "the knowledge of which had been the fruit of long and troublesome voyages in both hemispheres"—have received most important corrections or confirmations from exact methods of astronomical investigation applied to the lunar motions. It seems not unlikely that by the same means a yet more important element, the length of the sidereal day, which has been hitherto recognized by astronomers as the "one constant element," may be found to be no exception to the system of perpetual variation and fluctuation ruling elsewhere throughout the universe. It is not indeed precisely in this aspect that the great discovery we are now about to examine has been presented by its author. But this result, if, as appears probable, it should be established as the legitimate consequence of Adams' discovery, would undoubtedly be its most important fruit, and in the words of the late President of the Royal Astronomical Society, would deserve "to be ranked amongst the most important contributions to astronomical physics."

A lunar theory having been formed and its accuracy tested by careful observation of the lunar motions for a considerable length of time, it became practicable not only to predict the moon's motions and position at distant future epochs, but to determine with equal accuracy the motions and position of the moon at long past epochs. Now, in general, it would be a matter of great difficulty to ascertain whether these last-mentioned determinations coincided with the real motions of the moon in past times; for the observations of ancient astronomers were neither effected nor recorded with the accuracy requisite for such a comparison. But in eclipses of the sun and moon we have phenomena so marked and striking as to be almost independent (so to speak) of observational inaccuracy save of the grossest kind. Accordingly very early in the history of gravitation, only six years indeed after the publication of the 'Principia,' Halley pointed out the valuable results which would accrue from an examination of ancient eclipses recorded by Ptolemy and by the Arabian astronomers. He expressed also the opinion that the result of such a comparison would be to show that the moon was now moving with a greater angular velocity round the earth than she had moved with at the epoch of the earliest recorded observations. Dunthorne, in 1749, communicated to the Royal Society a paper in which, after comparing the observed and computed times of several lunar and solar eclipses, he expressed the opinion that the acceleration may be expressed by $10'' t^2$, where t denotes the number of centuries before or after the fixed epoch from which the reckoning is supposed to commence. Mayer, in his lunar tables published in 1753, made the acceleration $6'' \cdot 7$ in a century; but in 1770 he raised his estimate to $9''$. Lalande, Bouvard, and Burg arrived at results confirming those deduced by Dunthorne and Mayer.

The explanation of this peculiarity of lunar motion was not found to be an easy matter. Euler and Lagrange in turn attacked the problem without success: the former, in 1772, expressing as the result of his analysis that the secular inequality is not caused by the forces of gravitation; the latter, in 1774, concluding that the best solution of the difficulty is to deny the existence of the irregularity altogether. It is somewhat singular that in 1783 Lagrange, after discussing the effects of perturbing forces on the mean motions of the planets, stated it "as a truth rigorously demonstrated, that the mutual attraction of *the principal planets* cannot produce any sensible alteration in their mean motions." Had it occurred to him to apply his formulæ to the moon, to determine whether a similar freedom from secular inequalities exists among *the secondary planets*, he would not have had the mortification of seeing his gifted rival, Laplace, reap the honour of solving a problem which for ninety years had baffled the mathematical world.

Laplace first convinced himself that the records of ancient eclipses fully proved the existence of the secular inequality in the moon's mean motion. He then suggested three possible solutions, *viz.* that the phenomenon is due (i) to a continual retardation of the earth's diurnal motion, or (ii) to the existence of a resisting medium, or (iii) to the non-instantaneous transmission of gravity. Not satisfied with any of these solutions, he sought again and again to detect in the sun's disturbing action the source of the moon's secular acceleration; but unsuccessfully, until 1787, when he was able to announce that the true cause of the phenomenon lies in the secular variation of the eccentricity of the earth's orbit. To show how this happens it will be necessary to discuss briefly the important inequality called the *annual equation*, with which the minor inequality we are considering is most intimately connected.

Remembering that the sun's disturbing effect on the moon's motion is measured by the *difference* of his effects on the earth and moon, it will be evident that when the moon is in *syzygy* (that is, "new" or "full"), the attraction between the earth and moon is diminished, since the attraction of the sun on the nearer of the two bodies is greater than his attraction on the farther; but that when the moon is at or near either *quadrature* the attraction between the earth and moon is increased, since lines drawn from the sun to the earth and moon are nearly equal, but inclined at an appreciable angle. Now of these two disturbing effects the former is much the more powerful, since it is due to *inequality of distance*, while the other is exercised only through the effect of a minute *obliquity of pull*. And estimating the disturbing effects through a complete lunar revolution, it appears from similar considerations, that, on the whole, *the effect of the sun's action is to diminish the earth's attractive influence over the moon.*

Now any diminution of the central force which retains a body in its orbit is necessarily accompanied by an increase in the major axis of the orbit of the disturbed body. Accordingly the moon takes a longer period in accomplishing each revolution around her primary than she would but for the sun's disturbing influence. If this influence were constant, so also would the moon's mean motion be constant. But it is clear that when the earth is in or near perihelion, the sun's disturbing effect must be greater than when the earth is in or near aphelion. Hence arises the *annual equation*, the effect of which is that the lunar month is longer in our winter than in our summer, the moon's orbit attaining its maximum dilation in January (when the earth is near perihelion), and its maximum contraction in July. The period of the inequality is an anomalistic year, and its maximum amount is 10′, by which the moon is sometimes before and sometimes behind her mean place.

Now since the *annual equation* is due to the variation of the sun's disturbing influence from the mean value it would have if the earth's orbit were circular, it is clearly possible that any variation in the eccentricity of the terrestrial orbit would, besides affecting the amount of the annual *equation* (which it would inevitably do), affect the total amount of the moon's motion in successive anomalistic years. But the eccentricity of the earth's orbit has been continually diminishing since the date of the earliest recorded observations; and since the major axis of the orbit has throughout remained appreciably unaltered, the absolute extent of the ellipse in which the earth moves has been continually increasing, so that the probability prior to exact investigation is that, owing to this cause, the sun's disturbing action has been diminishing, and therefore the earth's influence, and with it the moon's mean motion, increasing.*

It will be as well to state the actual extent of the ellipticity of the earth's orbit, as some misconception appears to prevail on this point, and in works on astronomy reference is continually made to this feature, as if it were much more marked than it is in reality. Assuming the earth's mean distance from the sun to be 91,500,000 miles, her least distance is somewhat under 90,000,000 miles, her greatest somewhat over 93,000,000; the centre of her orbit being 1,533,600 miles from the sun. Thus the *eccentricity* of her orbit though small is appreciable. The *ellipticity* of her orbit, however, is quite insignificant by comparison. For the major axis of the orbit is 183,000,000 miles, and the minor axis 182,974,000 miles, the difference being less than one-7,000th part of either dimension, so that a finely drawn circle one foot in diameter would differ from a correct representation of the earth's orbit by less than the thickness of its own bounding line. Again, the eccentricity of 1,533,600 miles is subject to an annual diminution of 40 miles, owing to which change the semi-minor axis undergoes an annual increase of

* It does not *necessarily* follow, from the increase of the minor axis, that the average distance of the earth from the sun would be increased. The lagging of the earth near aphelion, and her rapid motion near perihelion of the more eccentric orbit *might* be more than sufficient to compensate for the smaller absolute extent of that orbit. Examination proves the contrary; but it is not to be assumed as self-evident, as is commonly done.

about $\frac{2}{3}$rds of a mile. These changes will progress (but more and more slowly after attaining a certain maximum rate) for about 23,950 years, when the sun's distance from the centre of the orbit will be reduced to 303,200 miles, and the semi-minor axis will only differ from the semi-major axis by about 500 miles.*

In such minute variations, thus slowly propagated, Laplace found the origin of the secular acceleration of the moon's mean motion. The average effect of the sun's action on the moon is to diminish her gravitation to the earth by one-179th part. The diminution of the earth's influence over the moon *during the month* varies inversely as the cube of the earth's distance from the sun. Now in the development of this inverse cube in a series proceeding according to sines and cosines of the earth's mean motion and its multiples, there is a term $\frac{3}{2}e'^2$ (e' being the eccentricity of the earth's orbit). The diminution of the moon's angular velocity contains the product $\frac{1}{179} \times e'^2$, and this product would be confounded with the mean angular velocity of the moon if e' were constant. But e' is continually decreasing; and the decrease of e' causes a diminished diminution—that is, an acceleration—of the moon's mean angular velocity.

Laplace estimated the acceleration at $10''\cdot1816213\ t^2$ (t as before), a result which agreed well with ancient eclipses, though not quite perfectly. When Lagrange applied with the requisite substitutions the formulæ he had already obtained, he arrived at a result almost exactly coincident with that of Laplace. Damoiseau, Plana, and Carlini obtained similar results; the largest estimate of the co-efficient being that of Damoiseau, who made it 10″·72. Hansen obtained the value 11″·93 (in 1842), corrected in 1847 to 11″·47, in 1857 to 12″·18, and recently to 12″·557.

But it was not merely the combination of six of the greatest names in the history of mathematics which seemed to point to this question as settled beyond dispute. A comparison of the results of calculation (when the larger values 11″ 93, 12″·18, or 12″·56 were used) with the records of ancient eclipses exhibited a correspondence so complete and exact, that no doubt could (or can) exist that the actual acceleration lies between 11″·5 and 13″·0. Six remarkable total or nearly total eclipses of the sun, and nineteen lunar eclipses recorded in the Almagest, are represented so closely by an

* Although the minuteness of the ellipticity of the terrestrial orbit is patent to calculation of the simplest kind, we repeatedly see the variation of this ellipticity cited as a possible cause of the prevalence at long past epochs of tropical or arctic climates in the temperate zones of our earth's surface. It may be readily shown that the greatest possible *decrease* of mean annual temperature due to this cause is less than one-7,000th part of the present mean annual temperature, and the greatest possible *increase* is also quite insignificant. Compare with the above-named difference of one-7,000th the difference of one-15th (460 times larger) between the total amount of heat received in a summer's day, in the northern and southern hemispheres.

acceleration equal to the mean of these values as to leave nothing to be desired. On the other hand, a change of 2″ or 3″ in the assumed value of the acceleration introduces difficulties into the explanation of most of the eclipses, and renders the occurrence of some of them physically impossible.

Despite this accordance, which would have deterred most men from the labour attending the re-investigation of a subject of such difficulty, Adams subjected the problem several years ago to strict and rigid scrutiny. In a memoir read before the Royal Society of London in 1853, he pointed out a cause of disturbance which Laplace and those who had followed him in the calculation of the acceleration had overlooked. We have seen that Laplace had investigated the effect of the central disturbing force only, assuming that the tangential disturbing force would give rise to no permanent alteration of the moon's mean angular velocity; or, in other words, Laplace had assumed that the area described by the moon about the earth in a given time undergoes no permanent alteration. Now, Adams pointed out that when the variability of the eccentricity of the earth's orbit is taken into account, in integrating the differential equations involved in the problem of the lunar motions (in other words, when the eccentricity is made a function of the time), non-periodic or secular terms appear in the expression for the moon's mean motion, and that their effect is to diminish considerably the co-efficient of the lunar acceleration.

In 1856 M. Plana published a paper, in which he expressed his acquiescence with Adams' views, but later he retracted this admission. In 1859 M. Delaunay deduced the same result as Adams, who then published the results of a new investigation, in which he had calculated terms even of the seventh order. The value thus calculated was 5″·7. Three months later M. Delaunay had carried the calculation to terms of the eighth order, and assigned 6″·11 as the value of the co-efficient.

At this stage the views of Adams became the subject of controversy, which for a long time occupied much attention among astronomers. In May, 1859, Pontécoulant entered the field. He objected energetically to the "new terms" developed by Adams, whose processes he characterized as "une véritable supercherie analytique." Hansen pointed out the remarkable coincidence between the value he had obtained and the records of ancient eclipses. Mr. Main examined the question, and came to the conclusion that Adams and Delaunay were in the right, but that Hansen's larger value was needed to satisfy the records of ancient eclipses. Leverrier, on the other hand, declared unreservedly against Adams and Delaunay: "Nous conservons des doutes et plus que des doutes," he said, "sur les formules de M. Delaunay—très-certainement la vérité est du côté de M. Hansen."

But, as Adams had himself remarked, the question was a purely mathematical one. Other methods of investigation were employed; fresh mathematicians entered the lists. Adams himself published two new solutions; Delaunay two more. Professor Donkin examined the problem by a method which had already been applied by Delaunay. Sir John Lubbock applied methods he had before employed in re-calculating other inequalities of the moon's motions. Professor Cayley devised and applied a perfectly new method of investigation. And lastly, Plana, who, as we have seen, had pronounced against Adams, subjected the question to renewed scrutiny. The result of these investigations was to place the correctness of Adams' views beyond dispute, and to assign 6″ as the approximate value of the secular acceleration of the moon's mean motion.

We find ourselves, then, face to face again with the original difficulty. But before considering the solutions which appear to offer themselves, it may be as well to exhibit the minuteness of the inequality which has been the object of discussion, and one-half of which still remains unaccounted for. Assuming 12″ as the actual value of the acceleration, and 6″ as the value of that part for which theory accounts, let us consider the motion of the moon in successive centuries. In the first place, it is necessary to point out the incorrectness of the statement we have seen more than once made, that the moon moves 12″ more in every century than she should do according to theory. That would leave the moon's motion *uniform*. Nor, again, is it correct to say that the moon advances 12″ more in every century than she had advanced in the preceding century. The proper statement of the nature of the acceleration is that the moon advances 12″ *farther* in every century than she would have advanced if she had retained the same mean motion during the century as she had at the *beginning* of that interval. As her mean angular velocity increases uniformly, it is clear that her position at the end of the century is *the same* as she would have had if she had moved throughout the century with the velocity she had in the *middle* of the century, and 12″ *behind* the position she would have had if she had moved with the velocity she has at the *end* of the century. In this last case she would, therefore, have gained 24″; and as she actually does start with this velocity at the beginning of the next century, and further gains 12″ from her acceleration, her total gain is 36″ during the second century. Similarly, it may be shown that in the third century she gains 60″, in the fourth 84″, and so on. Thus in each century she moves 24″ (or about one-78th part of her own breadth) farther than in the previous century. Theory accounts only for half this amount, leaving to astronomers the interpretation of the other half, *that is, of the moon's displacement by about one-*156*th part of* *her own breadth more in the course of any one century than in the course of the next preceding century!*

Adams himself offers no opinion as to the probable cause of the want of accordance between theory and observation which he has thus detected, beyond the remark that "if established the fact would be a most interesting one, and might put us on the traces of an important physical discovery."

It seems little likely that changes in any other element of the terrestrial orbit besides the eccentricity should (as has been suggested) appreciably affect the lunar acceleration. As to the direct action of the planets on the moon we have Euler's opinion that no part of the secular inequality is due to this cause. But it may be worth while to examine this point afresh.

Of the opinion offered by Euler that the acceleration is due to the resistance of an etherial fluid occupying space, Laplace in his earlier dealings with the subject expressed a not unfavourable opinion. But as it appeared that the same cause which produced the secular acceleration affected the motions of the moon's apsidal and nodal lines, and that the proportion existing between these variations corresponded closely with observation, which would not be the case if a resisting medium accelerated the moon's mean angular motion, he considered he had proved that no such medium exists. This proof is now set aside; and the possible effects of a resisting medium have still to be considered. It is hardly necessary to remark that if such a medium exists, the angular velocity of the planets must also undergo a slow process of acceleration. The argument in favour of a resisting medium, derived from the acceleration of Encke's comet, will of course not be overlooked.

Another solution, suggested and examined by Laplace, was that gravity acts progressively, not instantaneously. He showed that in order that such progressive transmission should cause the observed acceleration, its velocity must exceed the velocity of light eight millions of times. To explain that portion of the acceleration for which theory fails to account, the rapidity of transmission of gravity should be yet greater, should in fact be upwards of two thousand billions of miles per second! If, as seems probable, the difficulty can be explained without assuming the progressive transmission of gravity, it would follow of course either that the action of gravity is instantaneous, or that it is so greatly in excess of the last-named velocity that the effects of its progressive transmission are insensible.

In the possible effects of increments accruing to the mass, either of the earth or moon, we have another possible solution of the acceleration, or of a part of it. It is certain that both the earth and moon as they sweep together round the sun, are continually gathering fresh recruits from the bands of meteorites (pocket-planets, as Humboldt has termed them) which revolve in the interplanetary spaces. It is also certain that any increment thus caused in the mass of either is followed by a decrement (inconceivably minute of course) of the major axis of the lunar orbit, and a consequent increase in the moon's mean angular velocity around the earth.

There remains only to be considered the question of a possible retardation of the earth's motion of rotation. This solution of the difficulty was discussed by Laplace.* The only cause assigned in his time for such a retardation was the influence of the trade-winds upon the great mountain chains. He showed that this cause was insufficient to affect appreciably the earth's period of rotation. And further, as his calculations appeared to afford a complete explanation of the lunar acceleration, he felt himself justified in pronouncing his famous dictum on the constancy of the sidereal day. Of course, now that this accordance between theory and observation has been shown not to exist, the question is reopened. A cause of retardation not considered by Laplace has also been suggested, Mayer having pointed out (in 1848) that the tides "do work" on the earth, and that this work is the equivalent of a certain amount of "*vis viva*" lost in the earth's motion of rotation. M. Delaunay has now shown that this cause would probably be sufficient to account for the acceleration of 6″ in a century.

Assuming this explanation to be the true one, it appears that our great terrestrial time-piece, hitherto supposed to be keeping most perfect time, requires *correcting* and *rating*. In the course of the last 2,000 years it has lost nearly an hour and a quarter, and compared with its motion at the beginning of that interval, it is now losing one second in twelve weeks. The day is also lengthening, and will continue to do so until it is equal in length to the lunar day, that is, to our lunar month. The inhabitants of earth may console themselves, however; for the rate of change will diminish continually, and even if it did not, thirty-six billions of years would have to elapse before the change would be fully effected.

But although the races at present inhabiting the earth are not likely to be affected, either for good or evil, by the process of change we have been considering, it is impossible not to look with interest into the vista of the far future, and trace our earth in its gradual progress to the condition now presented by the moon,—to its degradation, may we not surmise, from the position it now holds as a life-sustainer. Looking backward into the far past, we see a progress of a like nature through which our moon has passed while the earth's strong influence has been exerted on her rotation,

* The explanation is suggested parenthetically by Newton in the second edition of the 'Principia:' "Halleius noster motum medium Lunæ *cum motu diurno terræ collatum* paulatim accelerari primus omnium quod sciam deprehendit."

coercing it down to correspondence with her revolution. We see her subjected, meanwhile, to other changes not less destructive. The bloom of life has long since passed from her face. Who shall say that our own beautiful earth will not one day resemble her?

Our great terrestrial time-piece being *slow*, actually and also rateably, it follows that all astronomical phenomena referred to any fixed past epoch, apparently occur too soon, just as they would do if timed by a "slow" clock in an ordinary observatory. In each century, for instance, the sun's apparent annual motion is accelerated by about $0''\cdot4$, the heliocentric motion of Venus by about $0''\cdot7$, and that of Mercury by about $1''\cdot7$. After long intervals of time such changes must become appreciable. We have here, then, a test which future ages will be able to apply to the explanation offered by Delaunay.

In whatever way the discrepancy detected by Prof. Adams may eventually be explained, no doubt can exist of the importance of the discovery. It may rank worthily with the noblest labours of Clairant and Euler, Lagrange and Laplace, Airy, Hansen, and Leverrier. One achievement alone since Newton's discovery of gravitation seems to claim a higher estimate,—in that achievement Adams shares equal honours with the illustrious Frenchman, Leverrier.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MEETING AT NOTTINGHAM, August, 1866.

The annual gathering of British philosophers may be regarded from a twofold point of view. By some it is looked forward to as a meeting where scientific papers of special interest are read and discussed, whilst by others it is treated as a holiday. To the former class the sections gave ample gratification, whilst to the other and more numerous class, including as it does the majority of the eminent scientific men present, who naturally embrace this opportunity of enjoying a holiday in company with friends of their own intellectual calibre, the numerous excursions which were arranged to different places of interest in the neighbourhood, afforded an agreeable relaxation from the scientific labours, which they visited Nottingham to get relief from, rather than to augment.

Writing after the close of the meeting we may pronounce it a moderately successful one; the numbers present having been 2,221, being about 200 more than at Birmingham, 580 less than at Bath, and 1,100 less than at Newcastle. There is no doubt that much, if not all of this falling off, is due to the most exorbitant price which was demanded for lodgings. Long before the meeting, scientific men were startled at being asked nearly seven times as much as they had been in the habit of paying for similar accommodation at Birmingham, Bath, or Newcastle, and during the meeting complaints of extortion were repeatedly heard in the reception-room. In many cases as much was asked to lodge a family for the time of the meeting as would pay the rent of the house for the year, and the result has been that a great number of scientific men who had intended going were frightened by the demands and went elsewhere, whilst not more than a fraction of the lodgings put down on the official list were tenanted. It is to be hoped that at future meetings of the Association this point will be properly attended to, and that the vital subject of lodging accommodation for the guests invited to a town be not left entirely to the discretion of a chairman and committee of the inhabitants, whose chief work in the present instance appears to have been to fix a prohibitory tax upon the letting of the apartments. We are very confident that had the deputation, which attended last year at Birmingham for the purpose of inviting the Association to meet at Nottingham, told the general meeting that it was their intention to fix the price of decent apartments for a family at about five times that ordinarily charged at a good hotel, their hospitable invitation would have been courteously declined. This is a subject which ought to be definitely mentioned in all future invitations, so that members may not again be asked 18*l.* for the same accommodation which cost about 55*s.* at Newcastle, Bath, and Birmingham. As a set-off against the rapacity of the lodging-house keepers, it deserves prominent mention that the private hospitality at Nottingham has been of a character unprecedented in the annals of the Association. Upwards of 500 houses in the town were opened for the reception, as guests, of visitors who before the meeting were totally unknown to their hosts, but who now retain a grateful recollection of their boundless hospitality and courteous generosity.

The General Committee met for the first time on Wednesday, the 22nd of August, when the several Reports of the Council, the Treasurer, the Kew Committee, and the Parliamentary Committee were read.

In the evening a crowded audience assembled in the theatre to listen to the Address of William Robert Grove, Esq., Q.C., M.A., F.R.S., President of the British Association.

The President's Address.

After a graceful allusion to the progress which had been made by Nottingham in the application of machinery, almost resembling organic beings in delicacy of structure, by which products of world-wide reputation were fabricated, the President proceeded to draw comparison between the British Association and other learned bodies. Apart from the novelty and freshness of an Annual Meeting, the great advantage resulting from the visits of this great Parliament to new localities was, that while it imparted fresh local knowledge to the visitors, it left behind stimulating memories. The tardy recognition of Science by the Government, and the ignorance of elementary scientific truths among so-called well-educated men, were eloquently alluded to, and the hope was expressed that the slight infiltration of scientific studies, now happily commenced in our Universities, our public and private schools, would extend till it occupied its fair space in the education of the young, and that those who might be able learnedly to discourse on the Eolic digamma would not be ashamed of knowing the principles of an air-pump, an electrical machine, or a telescope. Referring to the recognition of Science by the Government, the Report of the Kew Committee for this year afforded a subject of congratulation. The Kew Observatory might possibly become an important national establishment, and if so, while it would not lose its character of a home of untrammelled physical research, it would have superadded the Meteorological Department of the Board of Trade, with a staff of skilful and experienced observers.

The President then submitted to his audience certain views of what has within a comparatively recent period been accomplished by Science, what have been the steps leading to the attained result, and what, as far as we may fairly form an opinion, is the general character pervading modern discovery. One word gave the key to the discourse; that word was *continuity;* no new word, and used in no new sense, but perhaps applied more generally than it had hitherto been. The speaker proceeded to show that the development of observational, experimental, and even deductive knowledge was either attained by steps so extremely small as to form really a continuous ascent; or when distinct results apparently separate from any co-ordinate phenomena had been attained, that then, by the subsequent progress of Science, intermediate links had been discovered, uniting the apparently segregated instances with other more familiar phenomena.

This view was applied to the recent progress of some of the more prominent branches of science. In astronomy, the discoveries in gravitation as affecting double stars; the apparent exception to its influence in the case of some of the nebulæ; the recent researches on meteorites; the observations on the intra-mercurial planets; the identity in chemical composition between meteorites and terrestrial minerals; and their specific gravity as compared with that of the earth, were all adduced as affording proof of *continuity* pervading the universe. Optics likewise gave evidence in the same direction. The discoveries by spectrum analysis, and especially those of Mr. Huggins, on cometary, nebular, and stellar spectra, and especially of the temporary star which shone forth this year, and the deductions arising therefrom, were alluded to. The physical constitution of the Moon's surface, and the granular character of that of the Sun, were finally noticed in the astronomical review.

Magnetism and the conservation of force (in illustration of which a forgotten experiment, shown by the speaker a quarter of a century ago at the London Institution, was recalled), and the consequence resulting from the dynamical theory of heat in the retardation of the earth's rotation, were rapidly referred to. The exhaustion of our available force stored up in coal, and the latest discoveries of Professor Graham, as affording us indications of means of storing up force, were next glanced at, although the speaker said that at a time when science and civilization could not prevent large tracts of country being irrigated by human blood, in order to gratify the ambition of a few restless men, it seemed an over-refined sensibility to occupy ourselves with providing means for our descendants in the tenth generation to warm their dwellings or propel their locomotives.

The two very remarkable applications of the convertibility of force, attained by the experiments of Mr. Wilde and Mr. Holz, promised results of extended application, and were aptly described as showing how, by a mere formal disposition of matter, one force could be converted into another; and that not to the limited extent hitherto attained, but to an extent co-ordinate, or nearly so, with the increased actual force, so that, by a mere change in the arrangement of apparatus, a means of absorbing and again eliminating in a new form a given force might be obtained to an indefinite extent. As we may, in a not very distant future, need, for the daily uses of mankind, heat, light, and mechanical force, and find our present resources exhausted, the more we can invent new modes of conversion of forces, the more prospect we have of practically supplying such want.

Rapidly glancing at the considerable strides which were being made in physiology, by studying the relation of organized bodies to external forces, the speaker passed on to the facts recently brought to light by geological inquiries, which, while on the one hand they afforded striking evidence of continuity, on the other, by the breaks in the record, might be used as arguments against it; and supposing that the geological formation was of a continuous character, there came the question whether the different characters of the fossils represented absolute permanent varieties, or might be explained by gradual modifying changes.

The subject to which the President devoted most attention was the always popular one of the origin of species, and the question whether, what we term species, are and have been rigidly limited, and have at numerous periods been created complete and unchangeable; or whether, in some mode or other, they have not gradually and indefinitely varied; and whether the changes due to the influence of surrounding circumstances, to efforts to accommodate themselves to surrounding changes, to what is called natural selection, or to the necessity of yielding to superior force in the struggle for existence, as maintained by our illustrious countryman, Darwin, have not so modified organisms as to enable them to exist under changed conditions. The difficulty of producing intermediate offspring from what are termed distinct species, and the infecundity in many instances of hybrids, have been used as strong arguments against continuity of succession; on the other hand, it might be said that long-continued variation through countless generations had given rise to such differences of physical character, that reproduction was difficult in some cases, and in others impossible. In favour of this latter view the following illustration was adduced: Suppose M to represent a parent race, whose offspring, by successive changes through eons of time have divaricated, and produced on the one hand a species A, and on the other a species Z; the changes here have been so great that we should never expect directly to reproduce an intermediate between A and Z. A and B on the one hand, and Y and Z on the other, might reproduce; but to regain the original type, M, we must not only retrocede through all the intermediates, but must have similar circumstances recalled in an inverse order at each phase of retrogression—conditions which it is obviously impossible to fulfil. But there was another difficulty in the way of tracing a given organism to its parent form, which from our conventional mode of tracing genealogies, was never looked upon in its proper light. This was well illustrated by the speaker: Where were we to look, said he, for the remote ancestor of a given form? Each of us, supposing none of our progenitors to have intermarried with relatives, would have had, at or about the period of the Norman Conquest, upwards of a hundred million direct ancestors of that generation. Let anyone assume that one of his ancestors at that time was a Moor, another a Celt, a third a Laplander, and that these three were preserved while all the others were lost, he would never recognize either of them as his ancestor, he would only have the one-hundred-millionth of the blood of each of them, and as far as they were concerned there would be no perceptible sign of identity of race. From the long-continued conventional habit of tracing pedigrees through the male ancestor, we forgot, in talking of progenitors, that each individual had a mother as well as a father; and there was no reason to suppose that he had in him less of the blood of the one than of the other.

In indicating a few of the broad arguments on this subject, the speaker explained, that if he appeared to lean to the view that the successive changes in organic beings did not take place by sudden leaps, it was from no want of an impartial feeling; but if the facts were stronger in favour of one theory than another, it would be an affectation of impartiality to make the balance appear equipoised. Perhaps the most convincing argument in favour of continuity, which could be presented to a doubting mind, would be the difficulty it would feel in representing to itself any *per saltum* act of nature. We were forced by experience, though often unconsciously, to believe in continuity as to all effects now taking place, and the fair question was, Did the newly-proposed view remove more difficulties, require fewer assumptions, and present more consistency with observed facts than that which it sought to supersede? If so, the philosopher would adopt it, and the world would follow the philosopher—after many days.

In summing up this part of the argument, the speaker concluded by saying, that if we were satisfied that continuity was a law of nature, the true expression of the action of Almighty Power, then, though we might humbly confess our inability to explain why matter was impressed with this gradual tendency to structural formation, we should cease to look for special interventions of creative power in changes which were difficult to understand, because, being removed from us in time, their concomitants were lost; we should endeavour from the relicts to evoke their history, and when we found a gap not try to bridge it over with a miracle.

Physical Science. (Section A.)

The proceedings of this Section commenced on Thursday, August 23rd. In giving notices of the papers read, we shall adopt the plan followed on previous occasions, and confine our remarks to those subjects only which are likely to be new to our readers, and appear to be of general interest.

The first paper was a report on luminous meteors, read by Mr. Glaisher. In this report the Committee showed a marked degree of progress over their success in previous years. Not only have observations of three large meteors at the Royal Observatory, Greenwich, been confirmed by descriptions of observers at different places, so that the height and velocity of the meteors could be calculated; but the accounts sent by different observers has in several other instances led to the same satisfactory result. The radiant indicated by the charts of the meteoric shower of November last, is situated within two degrees of the place which it occupied during the interval of greatest meteoric activity in the year 1833. The heights of the November meteors is shown in this report to be the same as that of ordinary shooting stars, or sixty miles above the surface of the earth.

A strong probability exists of the occurrence, on the morning of the 13th of November next, of a more extraordinary meteoric shower than any that has yet been observed at the English Observatories, and the occasion of the return of the great November shower being one of very rare occurrence, the Committee have provided themselves with two spectroscopes specially adapted for analyzing the light of shooting stars. The average velocity of eleven meteors directed from Leo is $55\frac{1}{2}$ English miles per second. The average velocity of four meteors directed from Taurus or Perseus is 19 miles per second. As the former radiant region is hardly 20° and the latter more than 100° removed from the apex of the earth's way, it follows that the earth's motion of translation is plainly recognized by its effect of increasing the speed of the meteors from the former, and diminishing the speed of the meteors from the latter radiant point. Some observations on the spectra of meteors made at Hawkhurst by Mr. Herschel. are very interesting.

In one instance the appearance of a meteor in the spectroscope was unaltered, being that of an ordinary yellow shooting-star, leaving a yellow streak upon its course; and when the spectrum of the meteoric streak was diffused, a bright yellow very slender line was frequently observed in the spectrum on the side towards the red. The presence of the bright yellow line in a very conspicuous form in many of the streaks, points to the conclusion that sodium is frequently present.

Mr. Birt then read the report of the lunar committee for mapping the surface of the moon, from which it appeared that maps had been drawn on a scale of 100 inches for the diameter of the moon, some part of which had been enlarged to 400 inches, and a number of observations catalogued, which exceeded anything previously attempted. Mr. Browning gave a description of some recent improvements in astronomical telescopes with silvered glass specula, in which he described an improved method of mounting the speculum.

After a paper by Dr. Gladstone and Rev. T. P. Dale on dispersion equivalents, Mr. J. P. Harrison read a paper on the heat attained by the moon under solar radiation, from which it would appear that on the 22nd day of lunation, seven days after full moon, the temperature of the moon would be 840° F., a temperature of about dull redness, and exceeding the fusing point of tin and lead.

Amongst the papers read the next day was one by Mr. Hooper, on the electrical and mechanical properties of Hooper's India-rubber for submarine cables. He reduces the general coatings of India-rubber by means of heat to one perfectly homogeneous coating, separated by a film of vulcanized India-rubber, the advantages claimed are durability and resistance to mechanical injury, permanency of insulation at high temperatures, impermeability under long immersion and pressure in water, freedom from defects in manufacture, and high state of insulation with diminished induction. One hundred and fifty miles of this wire have been sent to India, and the insulation per nautical mile is about forty times better than that of the Persian Gulf core.

Professor Jellett then gave a paper on a fluid possessing the power of rotating the planes of polarization of rays, of the opposite ends of the spectrum in opposite directions; and Mr. Hind afterwards made some remarks on the recent extraordinary outburst of the variable star in Corona, from which it would appear that the change in the star did not take place with such astonishing suddenness as had been generally assumed. If such were the case, it destroyed the romance of its being a world in conflagration.

The next day was devoted to abstract mathematics. On Monday, Mr. Claudet described a new process for producing harmonious and artistic photographic portraits. One of the greatest deficiencies of photography is the impossibility of obtaining a well-defined image of all the various parts situated in different planes. The object of the author has been to discover a method of removing, if possible, from photographic portraiture that mechanical harshness which is due to the action of the most perfect lenses. The author effects this by gradually moving one of the lenses while the person is sitting, so that all parts of the image shall come successively *in* and *out of* focus, during one part of the exposure, and all in the same degree. By this simple contrivance, Mr. Claudet has succeeded in taking a photographic portrait without hard lines, but with the lights and shades blended in the most artistic harmony.

An elaborate paper followed on the North Atlantic Telegraph, by Mr. Holmes. After alluding to the various attempts which had been made to establish electrical communication between Europe and America, and the success with which they had been ultimately crowned, the speaker said that long unbroken lines of submarine cables were placed at a very great disadvantage in their transmitting power as compared with land lines; the retardation (or slowness of transmission of the currents) that takes place from the law of induction forming one very serious cause of interference. The constant flow of induced earth currents through the wire, variable both in their intensity and direction, is another disadvantage to the employment of long unbroken lines of submarine cables. In the words of Professor Wheatstone, the impediments to the rapid succession of signals have been proved to be in proportion to the length of the conductor. The project advocated by Mr. Holmes is a line of telegraphic communication between England and America, which is to be immediately carried into effect, *via* Scotland, the Faroe Islands, Iceland, Greenland, and the coast of Labrador, and known as the North Atlantic Telegraph. A glance at the map in the direction pointed out will at once show that convenient natural landing stations exist, breaking up the cable into four short lengths or sections, instead of the necessitous employment of one continuous length, as between Ireland and Newfoundland. It will also be found that the aggregate length of these sections is within a very few miles the same as that of the Anglo-American Cable. Not only will this subdivision of the cable reduce mechanical risks in submerging, but what is of far more importance, the retardation offered to the passage of the current through the several short sections is almost as nothing when compared with the unbroken length of two thousand miles. As regards the danger from icebergs, the depth of the soundings up the Julianshaabfjiord, where the shore end of the cable in Greenland is to be laid, indicate its security from ice when submerged. The landing places of the cable in Iceland are likewise in no way liable to be disturbed by ice of such a nature as to cause damage to the cable. In the discussion which followed, Mr. Holmes stated that the relay stations would probably be mechanical, and not subject in any way to the human hand. Mr. Varley, referring to earth currents, was happy to inform the meeting that, although the earth currents in the present Atlantic Cable were decidedly strong, the speed of transmission was not retarded in the slightest degree. Captain Maury objected to the present system of making deep-sea cables, as rendering them unnecessarily heavy. Mr. Holmes, in reply to Captain Maury, said that he thought he might go so far as to say that in the deep-sea sections of the cable no iron would be used.

Mr. Varley afterwards read a paper on certain phenomena which presented themselves in connection with the Atlantic Cable. These had reference almost entirely to certain phenomena of what he termed magneto-electric momentum, which were observed while testing the cable on board the Great Eastern, and also at Valentia after it was laid. The results, which were of the highest theoretical interest, will unfortunately not bear condensation.

In the Report of the Committee on the Transmission of Sound through water, it was stated that the rapid extinction of musical sounds in water rendered it almost hopeless to employ them for communicating signals in that medium, whilst an iron bar struck longitudinally could be heard at a very great distance. The Committee are continuing their observations on the possibility of using these sounds as fog signals.

A contribution by Mr. Evan Hopkins, "On the Depolarization of Iron Ships," was read. In this the author states that he has destroyed, or even reversed, in a few hours the polarization of vessels by means of electro-magnetic batteries. In order to test the practicability of this system upon a ship of the largest size and containing an enormous mass of iron, the ship 'Northumberland' was submitted to this plan, and on the 4th of August it was depolarized head and stern in a few hours by means of two Grove's batteries of five cells each and electro-magnets.

W. C.

Chemical Science. (Section B.)

The proceedings of this Section were opened by Dr. H. Bence Jones, F.R.S., with an address, in which he specially referred to the relations of Medical and Chemical Science and the present system of Medical and Scientific Education. In the medical profession the early years of study, those in which the mind is most capable of acquiring knowledge, are spent in great measure in learning Latin, Greek, Mathematics, or Divinity, and perhaps some modern language; and it is not till the age of twenty is past that one single step is taken towards the object required, and then the student is expected to compress the acquirement of Physics, Chemistry, Botany, Anatomy, Physiology, and the practice of Medicine, Surgery, and Midwifery, into the inadequate space of three years. What chance has a medical man of understanding the action of the chemical, mechanical, and electrical forces in the body, until a fundamental knowledge of chemistry, mechanics, and electricity has been first obtained?

The result is that chemists of the higher class, who have been hampered in their scientific education by no obsolete rules and traditions, are rapidly encroaching on the domain of the medical man. They not only understand fully the nature and uses of food and medicines, but they are becoming able to detect the first appearance of a multitude of chemical diseases. Their habits of investigation and their knowledge of the nature of the forces acting in the body are gradually leading them to become advisers in all questions regarding the health of the community. Intending to demonstrate this part of his argument by reference to a recent event, Dr. Bence Jones made the following remark:—"In confirmation of my opinion of the direction in which the treatment of disease is progressing, I may just refer to the cattle plague, which in 1745 was treated by Dr. Mortimer, at that time Secretary of the Royal Society, and therefore one of the most scientific physicians in the country, with antimony and bleeding. In 1866, two chemists (Dr. Angus Smith, Ph.D., F.R.S., and Mr. Crookes, F.R.S.) gave the only useful suggestions for combating the disease, namely, by the arrest or the destruction of the poison by chemical agents."

The first paper read was a preliminary report on the chemical nature of cast-iron, by Dr. Matthiesson. In it the author principally confined himself to an outline of the investigation which he proposed to make: an account of the results being deferred till next year.

Mr. Weldon read a paper on a new process for the manufacture of Soda, by the use of fluorine. The details were somewhat complicated and involving numerous chemical transformations. The result was said to produce soda without the consumption of anything except salt and coal. One great advantage of this process appears to be that the soda is yielded in the caustic state and not as carbonate. If successful on the large scale this will be a very important chemical discovery, and the profits of it millions.

After a paper by Dr. Attfield on the assay of coal for crude paraffin oil, and of crude oil and petroleum for spirit, photogen, lubricating oil, and paraffin, Dr. Stevenson Macadam gave an account of some experiments in which he had been engaged on the poisonous nature of crude paraffin oil and the products of its rectification. His attention had been drawn to the subject on account of the great mortality which had taken place among the fish in some Scottish streams, and the experiments fully proved that the destruction had been caused by the discharges from paraffin oil works.

Dr. Daubeny opened the meeting the next morning with a paper on Ozone. His researches tended to show that the atmospheric ozone was almost entirely due to plants, the green parts of which generate ozone, whilst they emit oxygen. The flowers generate no ozone.

Mr. Spence then described a new and probably important process for manufacturing white lead. It consists briefly in dissolving oxide of lead (from poor lead ores) in caustic alkali, and then precipitating by carbonic acid. The process was illustrated before the meeting.

Mr. Crookes then read some notes on Disinfection, principally in reference to the present outbreak of cholera in London. He gave several examples of the ignorance and waste characterizing the employment of disinfectants in different parts of London, and pointed out the absurdity of using at the same time, in the various parishes of London, disinfectants that were incompatible with one another. In one parish strong oxidizing disinfectants were largely used, in the adjoining one powerful deoxidizing disinfectants were employed; so that when the streams of sewage met from the different districts, the several agents exerted reciprocally an antagonistic action, thus expending their energies in mutual destruction, instead of uniting them in serviceable work. It was shown that oxidizing disinfectants were quite inadequate to cope with an evil of any great magnitude, but that antiseptics could be fully relied upon.

The principal paper of general interest the next day was one by Mr. Larkin, on the Magnesium Lamp. The distinguishing peculiarity of these lamps is that they burn magnesium in the form of powder instead of ribbon or wire. The metallic powder, mixed with sand as a diluent, is contained in a large reservoir, from which it flows through a tube at the bottom. Upon reaching the orifice, the metallic powder ignites, and burns with a brilliant flame. A small jet of gas issuing from the same orifice affords a permanent means of ignition, and the flow is regulated or shut off by a valve. At the first soirée in the Mechanics' Hall, where these lamps were exhibited, some complaint arose on the part of the ladies present, owing to the ghastly effect the light of the burning magnesium produced on their complexions. At the second soirée this fault was obviated in an ingenious way, by the addition of a little nitrate of strontia to the metallic powder, the result being to communicate a warm roseate hue to the light, and entirely to remove the unpleasant effect previously noticed.

W. C.

Geology. (Section C.)

Though in this Section there were, perhaps, scarcely so many as usual of those commonly regarded as the leaders of geological opinion, a considerable number of eminent and diligent geologists were in attendance, and took an active part in the proceedings.

In his inaugural address, the President of the Association stated that most geologists of the present day, instead of holding that the breaks or chasms in the geological record represent sudden changes in the formation of the earth's crust, adopt the alternatives that they arise from dislocations occasioned since the original deposition of strata, or from gradual shifting of the areas of submergence; that the advance of science has more or less filled up the gaps supposed to exist between the characteristics of the extinct and the new species; and that the apparent difficulty of admitting unlimited modification of species would seem to have arisen from the comparison of the extreme ends of the scale, where the intermediate links or some of them were wanting.

In these statements the President struck the key-note of the proceedings of the Geological Section during the following week. Never, probably, did the authors of papers, or those who took part in the discussions which they elicited, appeal so little to convulsion, cataclysm, or catastrophe. Professor Ramsay, in the address with which, as its President, he opened the Section, echoed back the sentiments which his Chief expressed on the previous evening. Having described the contortions of mountain chains and, in fact, the disturbance of strata generally, especially those which occur in North Wales, Scotland, the Alps, and Cumberland, he remarked, "Respecting the agencies to which these changes are due, one opinion is that we now live in a world, as nearly as can be in a finished state, which has to suffer no more catastrophes; another, that we are now remaining in a temporary state after a succession of spasms, but that they may recur again at some period a long way before us; or, again, that the state of tranquillity we now enjoy has been the seeming order in all time, as far as geologists can trace back the action of the processes which have brought us to the present condition of the world. These are the three leading opinions, and my own inclines to the last." Having discussed the connection of life with the modifications which have taken place in the crust of the earth, he summed up by observing that "the great principle remains of a succession of life which shows a method of progress—the old disappearing and the new coming in; that the breaks in continuity have a close connection with unconformability of strata; that there never has been universally over the world any complete destruction of life; that the succession of existences has gone on in regular order and sequence; but that we have lost a great number of the records—whole chapters, whole books—by the immense disturbances in the earth's crust. Putting all things together, we are pointed to the conclusion that all these changes have been so slow and gradual, that to the occupants of the old time, if they had had reason to observe, everything would seem to go on in the same slow, steady, and apparently undisturbed manner in which they appear to us to go on now; and if this be true, instead of having recourse to unusual catastrophic action to explain what is seen to have resulted, it all resolves itself into the process of time,—the effect produced in long spaces of time by small causes which were accumulative, and so were more than equal to all the unusual destructive forces which were attributed to the igneous rocks, which latter, with all other rocks, yielded to those causes which have brought about the astonishing changes which the world has so visibly undergone, resulting in the present physical geology and geography of the earth's surface."

Though the number of papers sent in was smaller than that of several immediately preceding years, and though none of them contained an announcement so revolutionary as that made at the Bath Meeting of the discovery of organic remains in the "Azoic" rocks, the supply was so large as to render it necessary for the Section to sit more than once long beyond the prescribed hour, and the quality betokened steady and general progress and occasionally drew an audience sufficient to fill the very large room in which the Section was located.

Mons. Pierre de Tchihatchef, a distinguished Russian traveller, gave in excellent English an interesting account of "Eight Years' Researches in Asia Minor," where, entirely at his own expense, he had journeyed over 21,000 miles, and had occupied himself in various branches of scientific research, especially geology and botany.

In their "Second Report on the Geology of St. David's, Pembrokeshire," Messrs. Hicks and Salter stated that the rocks of the district are divisible, in ascending order, into the Harlech, Menevian, Ffestiniog, Tremadoc, and Arenig or Skiddaw groups, the whole being crowned with the Llandeilo beds; that about 65 or 70 new species of animals had been found, peculiar to the district; that the Harlech or lowest group have a passage downwards into the central syenitic mass, so distinct and gradual as to induce the belief that that mass is throughout no other than altered Cambrian; and that the Menevian is the great fossiliferous group, containing more than 40 species, including 3 species of *Paradoxides*, which are never found together.

Mr. Nicholson, in his paper "On Fossils from the Graptolite Shales of Dumfriesshire," stated that in the shales near Moffat, long known to yield graptolites, he had detected numerous bodies which, in their most perfect condition, were bell-shaped, averaged three-tenths of an inch in length and two-tenths in breadth, and were provided at one extremity with a prominent spire, the other terminating in a nearly straight or gently curved outline, and presenting, somewhere within their margin, an elevated point surrounded by several concentric ridges disposed with more or less regularity. In most cases the bodies were free and independent, but they occasionally occurred in such close juxtaposition to *Graptolites Sedgwickii* as to justify the belief that they were ovarian vesicles, at first attached to the parent stem, but finally becoming swimming zooids. If this conjecture were correct, the *Graptolitidæ* would have to be referred to the *Hydrozoa*, and would find their nearest living analogues in the *Sertularidæ*.

In a paper "On a peculiar Denudation of a Coal Seam in Coate's Park Colliery," Mr. Oakes expressed the opinion that the observed phenomena distinctly proved the existence of an ancient, gigantic, rapid river, the bed of which is now 160 yards below the surface.

As might have been anticipated, Sir R. I. Murchison's paper, "On the Various Tracts of England and Wales in which no Productive Beds of Coal can reasonably be looked for," attracted a very large audience. The author, having described so much of the geology of Britain and France as bore on his subject, and having pointed out the bearings of the facts which he brought forward, thus concluded his discourse: "By excluding from the inquiry into the present or probable future coal supply of England and Wales all the tracts of crystalline and Palæozoic rocks which rise out from beneath the carboniferous strata, and in which no trace of coal can ever be discovered, and also all those secondary and tertiary rocks beneath which it is hopeless to look for coal, it will be seen that the existing and possibly future supplies have, for all practical purposes, an approximately defined limit, and that they range over little more than one-eighth of England and Wales, or an area of about 6,000 square miles. I fully appreciate the anxious desire which is felt by all those persons who are interested in the future welfare of their country, to have the subject fully and fairly inquired into; the more so as I have now, in conclusion, to announce that by the last inquiry made by Mr. Robert Hunt, the last year's consumption of coal reached the portentous figure of nearly one hundred millions of tons. I have simply endeavoured in this communication to indicate to the public that they are not to believe in the almost boundless range of our coal fields which some persons would assign to them."

From Mr. Hedley's communication "On the Sinking of Annesley Colliery," about eleven miles from Nottingham, it appears that the shaft is at present 200 yards deep; that the formations through which it passes are New Red Sandstone, 68 feet; Permian, about 150 feet; below which are the usual alternations of sandstones, shales, thin coals, and fire clays of the Coal measures, which dip due east, about 1 in 36, conformably with the Permian beds; that when about six feet above it, water burst up from the Magnesian limestone in such abundance that the three pumps which were constantly employed discharged 1,500 gallons per minute; and that as the sinking progressed it was necessary to line the shafts with cast-iron tubing to the depth of 98 yards, below which ordinary brickwork sufficed. The author regarded this sinking as affording conclusive proof of the practicability of sinking through the water-bearing strata which cover a large area of Coal measures in the eastern part of Nottinghamshire.

Professor Hitchcock, of Lafayette College, United States of America, stated, in his paper "On the Geological Distribution of Petroleum in North America," that the petroleum produce of the United States increased from 24 millions of gallons in 1862, to upwards of 91 millions in 1865; the value of the latter quantity being about four million pounds sterling. Petroleum sometimes occurs in synclinal basins, in cavities and fissures in the strata which may or may not lie in synclinal basins, in long lines of faults, and beneath anticlinal arches. Great wells involve three essentials:—Plenty of bituminous matter in the petroleum formation, from which an abundant supply may be drawn; cavities and crevices formed by the unequal elevation of the strata; an impervious cover, like the roof of an anticlinal, to have prevented the escape of the petroleum gas in past ages. In the American continent, an area several hundred thousand square miles in extent is underlaid by oleiferous formations, which are known to have a vertical range from the Pliocene, through the Cretaceous, Triassic, Carboniferous, and Devonian, to the Upper and Lower Silurian. The quantity and quality of the petroleum is proportional to the depth to which the wells descend. The lightest oils come from the greatest depths. In conclusion, the author asked, and commended to the attention of the Association, the question, which he confessed himself unable to answer, "How was the petroleum formed?"

Kindred to the foregoing was Professor Ansted's paper "On

Intermittent Discharges of Petroleum and large Deposits of Bitumen in the Valley of Pescara," which runs up from the Adriatic to a narrow and important gorge of the Apennines, about 35 miles from the sea. Near the gorge the rocks are limestones overlying chalk. The former are cavernous, and bitumen exudes freely in summer from the exposed surfaces wherever there are cracks. A couple of miles from the valley to the south there are water-courses down which much water rushes after rain. There are many swallow holes into which water enters, and from openings in the rocks below large bodies of water sometimes issue. From one of these, when rain has fallen, the water comes out mixed with petroleum. The author saw about 1,500 gallons collected in two days, or 1,000 gallons of available petroleum, yielding valuable light and heavy oils and asphalte on distillation. At Letto, about half way towards the coast, and within an area of five miles' radius, are enormous deposits of bitumen and much sulphur. At Letto itself there is a vast gorge filled up with little else than a dyke of earthy and some very pure varieties of black and brown bitumen, which the author traced 1,600 yards. On the north wall of the dyke was an enormous deposit of native sulphur in crystals.

In a second communication, the same author gave an account of a "Mud Volcano close to the South-western Extremity of the Lavas on the Flanks of Etna," about 600 feet above the sea, and which was in a state of eruption in January last. It commenced by the outburst of a strong jet of muddy water, which rose about six feet, at a boiling temperature. Several such jets followed from other places a few yards off. The temperature diminished slowly from the commencement. There was neither noise, flame, visible vapour, stones, nor lumps of solid matter, but much gas bubbling through the water, and some naphtha. The gas was chiefly carbonic acid, which, in large bubbles, issued by puffs of about 40 per minute. A multitude of smaller jets came out from cracks in the ground at various points within an area of about twenty acres.

Mr. H. Woodward, in his "Second Report of the Fossil Crustacea," described a new species of the genus *Æger* from the Lias of Charmouth; a new genus of Phyllopodous Crustacea from the Lower Silurian Shales of Dumfriesshire; the oldest known British Crab, from the Forest Marble of Malmesbury, Wilts; and six species of the genus *Eryon*—five from the Lias, and one from the lithographic stone of Solenhofen. The author stated that having lately had the opportunity to examine specimens of *Limuli* from the Coal Measures, he was enabled to demonstrate the connection between this division of Crustacea and the more ancient *Eurypteridæ* on the one hand, and the recent King-crabs on the other.

Mr. Burton's paper on "The Occurrence of Rhætic Beds, &c.,

near Gainsborough" established the identification of the deposits in question with the Rhætic beds of the Continent, and thus gave to this formation an extension northwards beyond that it had been previously known to possess.

Mr. Seeley, in illustration of his communication on "The Character of Dolichosaurus, a Lizard-like Serpent of the Chalk," submitted to the Section a beautiful specimen of the fossil. His general conclusion was that it was a new type of creature between the serpent and the lizard.

In Mr. Walker's paper on "The Lower Green Sand of Bedfordshire," some account was given of the occurrence of phosphatic nodules in a conglomerate supposed to represent both the Gault and the Shanklin Sands, and which occurs near Sandy.

From Mr. Mitchell's "Report on the Alum Bay Leaf-bed," it appears that this bed is the band of white clay occurring in the Lower Bagshot beds in Alum Bay. It is about six feet thick, but one portion only, a few inches in thickness, contains the plant remains. No other fossils have been noticed. When first exhumed, the outlines and even the most delicate venation of the leaves are clearly visible; but a few hours' exposure to the air obliterates the more delicate marks. About 470 specimens have been obtained.

Closely related to the subject of this paper was that by the Rev. Professor Heer, "On the Miocene Flora of North Greenland." Different voyagers have, from time to time, brought from Greenland, and lodged in various museums in Britain and Ireland, rich collections of fossil plants, all of which have been submitted to Dr. Heer. They were all found 1,080 feet above the sea, on a steep hill, at Atanekerdluk, opposite the Isle of Disco, in lat. 70° N. A total of 66 species have been recognized, and from them and their associated facts, the author infers that they must have grown where they were found; that they belonged to a Miocene flora rich in species, at least some of which extended to still higher latitudes; that in the Miocene epoch the climate of North Greenland was warmer then it is at present by fully 16° C., or 28·8° F.; and he thinks that "we could not by any re-arrangement of land and water produce for the northern hemisphere a climate which would explain the phenomena in a satisfactory manner." "We must only admit," he adds, "that we are face to face with a problem whose solution in all probability must be attempted, and we doubt not completed by the astronomer."

Mr. Taylor, in his "Relations of the Upper and Lower Crags, near Norwich," contended for the existence of four separate "Crags," —the Coralline or most ancient, the Red, the Norwich, and the

Upper or most Modern. The last he regarded as a connecting link with the Glacial series.

In a paper on "The Anglo-Belgian Basin of the Forest-bed of Norfolk and Suffolk, and the Union of England with the Continent during the Glacial period," the Rev. J. Gunn came to the conclusion that the forest bed is the estuarial deposit of some great river or rivers which flowed westwards, closed to the south by a ridge of chalk hills, but open to the sea on the north; and that this ancient river is now represented by the several rivers which flow into the German Ocean between the mouths of the Scheldt and the Rhine. He strongly suspected that the separation of this country from the Continent took place more recently than geologists generally supposed.

In introducing his "Additions to the List of Fossils found in the Boulder Clay of Caithness," Mr. Peach suggested that the clay had been transported to the shores of Caithness by icebergs, which when launched picked up some of the sea bottom with its organisms, and on their voyage, wherever they touched, added to their burthen by picking up more organisms, stones, &c.; that on finally stranding, the mud, stones, sand, and shells of Caithness became intermingled with them; and that when the ice slowly melted the burthen was dropped confusedly together, but was capable, nevertheless, of telling distinctly the story of the voyaging and collecting of the berg.

Mr. Brown, in a communication on "The Drift of the Weaver Hills," described a deposit of siliceous sand, white plastic clay, and other materials, at an elevation of upwards of 1,000 feet, where it is overlaid by the Boulder clay. The author was of opinion that it was not of fresh water origin, and that it was perhaps contemporary with the late Tertiaries—for example, the Norwich crag.

The aim of Mr. Pengelly's paper, "On Raised Beaches," was to call attention to the facts: 1st. That accumulations of blown sand occasionally assume the character of raised beaches. 2nd. That it is not safe to conclude, in the absence of other evidence, that raised beaches differing in height by as much as even thirty feet, necessarily belong to distinct periods. 3rd. That it is possible that what, in a small vertical section having the direction of the coast line, appears to be but one raised beach, may really be two. 4th. That, all other things being the same, raised beaches are likely to be most numerous on a coast composed of durable rocks.

In Dr. Ransom's paper "On the Occurrence of *Felis lynx* as a British Fossil," a description was given of a series of caves or fissures —and especially of one known as the "Yew-tree Cave,"—which on the borders of Nottingham- and Derby- shires occur in the Permian rocks, and pass through the whole thickness of the Magnesian limestone to an unknown depth in the lower New Red Sandstone beneath. A large number of bones—unrolled and, with one exception, ungnawed, but occasionally much broken—were found embedded in a red loam. Amongst them was a lower jaw, which Professor Owen had identified as that of *Felis lynx* (variety *Cervaria*), a north Asiatic animal, and a fossil new to Britain.

In the "Second Report on the Maltese Caves," Dr. L. Adams, after giving descriptions of the characters and deposits of several Caverns and Fissures in Malta," thus concludes: "From a digest of all the evidence deducible from the geological structure and fossil fauna enumerated in this and the previous report, it may be inferred that the old Miocene formations of which the Maltese group are composed underwent extensive upheavals and formed a considerable tract of land, tenanted by vast herds of hippopotami, elephants, and other quadrupeds, together with birds and reptiles almost all specifically distinct from any species yet found elsewhere, and at a time when the land testacea were identical with those now inhabiting the islands; that at a subsequent period the whole, or at least by far the greater portion, of this area was again submerged, and re-elevated at a still later period, when, after various oscillations of level, the subterranean movements ceased, leaving the present insular fragments."

The "Kent's Cavern Committee" also sent in a "Second Report," from which it appeared that during the twelve months which have elapsed since the First Report was presented, they have carried on their labours in the original rigorous method, and invariably in virgin ground. A large number of bones have been found, but so far as is at present known no new species have been added to the list of animals given last year. Upwards of 70 flint "implements" have been met with, making a total of something more than 100 from the commencement of the work. They resolve themselves into three classes—flakes, and lanceolate, and oval implements. The lower levels of cave earth have, on the whole, yielded fewer tools than the upper, but those found in the lowest zones are the most elaborately finished of the cavern series of implements. A *whetstone* and several pieces of *burnt* bones have been found in the cave earth, with the flints and the remains of the extinct mammals. The Committee observe, in conclusion, that "the careful and unremitting labour bestowed on the cavern during the last year and a half has produced a large accumulation of facts, consistent with one another and with those recorded by the earlier explorers. Of the discoveries made, the uniform testimony is that beneath a thick floor of stalagmite, so difficult to work as to require excellent tools and untiring perseverance, there are everywhere found, inosculating with bones of extinct mammals, and undoubtedly inhumed at the same time, human industrial remains of a character so humble and so little varied as to betoken a very low type of civilization."

Mr. Spence Bate, in his "Attempt to Approximate the Date of the Flint Flakes of Devon and Cornwall," chiefly confined himself to two localities in Barnstaple Bay, North Devon—one on the north and the other on the south of the mouth of the Taw,—the former being connected with the "Raised beach," the latter with the "Submerged forest"—both long and well known to geologists. From a study of the phenomena, the author concluded "that the flints are more recent than the most recent elevation of land on that coast;" that the submergence of the forest was due, not to any subsidence of the land, but to the slow landward retreat of an extensive "pebble ridge," which formerly protected a low-lying tract of land and enabled trees to grow on an area below the sea level; and that "there is no evidence to show that the flint flakes may not have been coeval with the period that immediately preceded the introduction of Roman civilization into this country."

In the communication by Mr. Oldham, "On the Discovery of Ancient Trees below the Surface of the Land, at the Western Docks now being constructed at Hull," it was stated that at a depth of 40 feet below the level of the adjoining land, trees, some of them of gigantic size, were met with in all positions. They are broken off within three feet of the roots, which still remain *in situ*. It was estimated by the author that they cannot be less than 3,000 years old.

Mr. Peacock gave some account of "A Case of Gradual Change of Form and Position of Land at the South End of the Isle of Walney," stating that the sea encroaches at the average rate of nearly eight feet in width per annum, the land being washed from the west towards the south-east and north-east points, where it remains.

The conclusion at which Mr. Wynne arrived, in his paper on "The Physical Features of the Land as connected with Denudation," was that "both marine and sub-aerial agencies have contributed to form the features of the land, the latter labouring to destroy the traces of the action of the sea, as well as those features which it had itself produced."

Mr. Topley, in his paper on "The Physical Geography of East Yorkshire," stated that his object was to explain the relation of the present surface outlines to the internal structure of the district of Cleveland. He was of opinion that the present scenery of Yorkshire was due not to marine action, but to subaerial denudation.

In his "Report on Dredging amongst the Hebrides," Mr. Gwyn Jeffreys called attention to certain geological considerations of high theoretical interest, and which produced an animated discussion.

Dr. Le Neve Foster stated that the facts of the "Curious Lode or Mineral Vein in New Rosewarne Mine, Gwinear, Cornwall," led him to infer that the fissure which it occupied had been filled partly mechanically and partly chemically, and that the various deposits had been introduced at six different times. The vein, however, was chiefly remarkable on account of its containing rounded pebbles.

Dr. Beke gave a brief account of the island of St. John, in the Red Sea.

Biology. (Section D.)

The title "Biology" was this year adopted for Section D in place of the old one "Zoology and Botany," and it was recommended by the Council of the Association that two special departments should be added to it,—one of Physiology and another of Anthropology. Accordingly Section D had three places of meeting, in which papers were simultaneously read. A large number were thus disposed of, equal in amount to those of any three of the other Sections.

Professor Huxley presided over the Section, while Professor Humphry, of Cambridge, took charge of the Physiological, and Mr. Wallace, the traveller, of the Anthropological department.

On the second day of meeting of the Sections, the departments of Section D were summoned to meet in one room, in order to hear an address from Professor Huxley on the classification and scope of the Biological Sciences, with especial reference to the arrangements made with regard to the departments of Section D. The President commenced by observing that he was afraid some present would be disappointed, as he did not anticipate any controversy, nor any heresy. If any persons should be induced to leave the room in consequence of that statement, he should be very glad. He then proceeded to discuss the nature of Biological Science. All Biological inquiries resolved themselves into either the study of *form* simply, or the *reason* of that form's occurrence. The Embryologist studied a series of forms only, the Anatomist and Histologist studied form, Histology being assuredly nothing but the anatomy of minute parts. The Taxonomist arranged and classified animals with regard to the forms which they presented; the subject of distribution related to the position occupied by various forms of life at the present time on the surface of the globe, and in past times, when it became an important aid to the geologist, as the Science Palæontology. All these studies had regard only to the form, and did not deal, strictly speaking, with the reason why these forms existed, or their functions in any way. Hence Development, Anatomy, Taxonomy, and Distribution were arranged under the great division Morphology. Physiology was the other great division of Biology; comprising the study of the functions of individuals and their organs, and that other branch of inquiry, of a far wider and more comprehensive nature, the reason of the existence of all forms of life, their mutual relations and the causes which affected their form and habit. This was almost a new study, and its foundations as a science had been laid by Mr. Darwin.

With regard to the arrangements of Section D, it was impossible for one assembly to take interest in and discuss papers on all the branches of Biological Science. The reason of this was to be found in the utter neglect of Scientific education in our schools and the indifference of the Universities. The most philosophical division of the Section would doubtless be divided into two, a Morphological and a Physiological, but this would not be convenient, and it was doubtful if a strictly Physiological Section could be well maintained, since a thorough acquaintance with the Sciences of Physics and Chemistry was necessary for the pursuit of Physiology. The Council of the Association had recommended, purely as a matter of convenience, that a department should be allowed for that numerous body of persons who were pursuing the Science of Man; and that another should be arranged in order to facilitate the discussion of questions in which the medical men who attend the Association are interested, and which have not a general interest. This department would receive the title of Physiology, though the term was used of course in a limited sense.

In the discussion which followed, Dr. Humphry expressed great dissatisfaction with the subordinate position assigned to his department (Physiology). Dr. Hughes Bennett wished for equal sections of "Zoology and Botany" and "Physiology and Anatomy." Sir John Lubbock thought the present arrangement satisfactory, since it prevented the physiologists from taking papers on general anatomy. The President refrained from expressing any opinion; saying that what had been done was done by the Council for convenience.

In the brief notice of the papers read in this Section which we shall give, the papers bearing on systematic Zoology, Anatomy, Development, Distribution, Physiology, and Anthropology, will be taken in order of subjects. First, with regard to general anatomy, zoology, and botany (a vague term, but indicating very well the character of many papers), Professor Alfred Newton read the report of the committee appointed to investigate the extinct birds of the Mascarene Islands. Almost immediately after the appointment of the committee last year, Mr. George Clarke, of Mauritius, had discovered a large deposit of bones of the Dodo in the swamp known as the "Marcaux Songes." By this now celebrated discovery the whole skeleton of the Dodo had been made known, excepting the end of its wing; whereas before the head and foot at Oxford, the skull at Copenhagen, the foot in London, and the beak at Prague, were all the specimens known of the bird. The committee intend to thoroughly search the marsh for the tip of the Dodo's wing; and also to complete their investigation of the bone-caves of Rodriguez and Bourbon.

Dr. Sclater read a paper on the American Prong-horn *Antilocapra Americana,* in which he pointed out that this animal had characters intermediate between those of the Bovinæ and Cervinæ. The prong-horn had a branching antler like a stag's, but this was covered with a horny sheath, like that of oxen in character. This horny sheath, however, unlike that of any Bovine animal, was periodically cast off, exposing a new horn beneath. This had been observed in the gardens of the Zoological Society in London. Dr. Sclater submitted a classification of the Ruminating Artio-dactyls to the Section, in which he separated the *Antilocapra* from the other Unguligrades. Professor Huxley elucidated Dr. Sclater's paper by some remarks on the nature of horns. He criticized the classification offered by Dr. Sclater, since he considered the Tragulidæ, or musk-deer, as very distinct from the other Ruminants.

Dr. Carmichæl McIntosh read a paper "On a New Molluscoid Animal, a Tunicate," which he had obtained from the west of Scotland. It appeared to be closely allied to Pelonaia, of Forbes and Goodsir. The same gentleman covered the wall of the room with some beautifully coloured and highly-finished drawings of Turbellaria, Annelida, Nudibranchiata, &c., which he had obtained from North Uist, a list of which was submitted to the Section; many of the forms were new. He also exhibited some smaller drawings of great beauty, destined for the Ray Society's volume on British Annelids. Among the specimens shown was one of a deformed star-fish, having completely the form of a human figure. It is very remarkable that another similar specimen is in the national collection.

Mr. C. Stewart, of Plymouth, read a paper "On the Structure of the Echinoidea Regularia, with Special Reference to their Classification." The value of the minute structure of the "lantern" and of the spicules of the alimentary canal, as systematic characters, had been to a great extent overlooked. Mr. Stewart gave, in a condensed form, the result of much laborious investigation among the Echinodermata, and showed that many minute details in the skeleton were valuable as differentiæ.

A letter from Dr. Carpenter was read with reference to the specimens of *Comatula* procured for him by Mr. Gwyn Jeffreys in the Hybrides. The number of dorsal cirrhi in the specimens of *C. rosacea* was much larger than he had elsewhere observed, whilst the specimens of *C. celtica* were exceedingly fine, almost leading to the belief that they were stunted forms of the splendid *C. Eschrichtii* of Iceland. The presence of very many attached Foraminifera and zoophytes on the *Comatulæ* confirmed Dr. Carpenter in his opinion expressed in his unpublished memoir, in the hands of the Royal Society, that the adult *Comatula* is essentially a stationary animal.

Mr. Ray Lankester described the anatomy and asexual reproduction of *Chætogaster*, a minute worm, one-eighth of an inch long, which clings by hooklets to the bodies of water-snails. He showed that the budding and giving off fresh worms by growth from behind (so that chains of from four to sixteen worms occur) was in this case the result of the tendency to produce three abdominal and one cephalic segment, which the fourth segment always possessed. The most remarkable points in the anatomy of the worm were the very small number of segments constituting an individual—the broad terminal mouth and oral bristles—and the absence of cilia in the whole organism. Professor Huxley said he had observed many of the points mentioned by Mr. Lankester himself, and could speak to his accuracy. He would suggest a comparison between *Chætogaster* and *Sagitta;* he was inclined to consider it as an immature form.

Mr. Henry Woodward, of the British Museum, brought forward an interesting classification of a branch of the Crustacea, in his paper "On the Structure of Limulus, Recent and Fossil." He associated the great *Eurypterus* and *Pterygotus* with the king-crabs of the present day, connecting them by the Limuloid crustaceans of the carboniferous strata, some forms of which he was the first to describe. He drew a parallel between the Decapodous crustaceans and this group. The *Eurypteri* represented the Macroura; the Limuloids and *Hemiaspis*, the Anomoura; while *Limulus* itself, first appearing as early as oolitic strata, represented the Brachyoura. Mr. Woodward had very carefully worked out the number and fusion of somites in the head, thorax, and abdomen of the Limulus itself, and those crustacea he wished to rank with it. Professor Huxley thought that the Eurypterida must be kept distinct from the other crustacea.

Dr. Ransom, of Nottingham, read a paper "On the Structure and Growth of the Ovarian Ovum in Gasterosteus Leiurus," the result of very careful study and observation. Dr. Ransom regards the germinal spots, which are readily examined in very young ova, as consisting of a material resembling protoplasm only in its great instability and tendency to vacuolate. The action of water and other agents on the tissues of the ovum was carefully discussed. The observation of the dotted structure of the yelk sac has led Dr. Ransom to ascertain that it does not grow by the apposition of either internal or external layers, but by interstitial development. In studying such structures it is very necessary to use a suitable medium. Dr. Ransom recommends a mixture of glycerine and water, which can readily be brought to the right density.

Dr. W. Turner, of Edinburgh, described the very curious method of gestation in a new fish, belonging to the genus *Arius*, which he had received from Ceylon. The female fish deposits her eggs, which are then taken into the mouth of the male, who swims about with them until they hatch. Dr. Turner's correspondent had been very careful to avoid any mistake or imposition in the matter. The fish lived in stagnant pools in marshy ground, where they were caught in large numbers by the natives. Dr. Günther, of the British Museum, said it was very remarkable that in South America there was a fish almost exactly like that which Dr. Turner had described, and Agassiz had lately described several others from the Amazons possessing this curious method of gestation; none, however, had been observed in Africa. Fishes of the most distant regions were often most alike, as, for example, certain species found in Madeira and in Japan.

Dr. Cobbold read one of his horrifying papers "On the Entozoa of the Dog in Relation to Public Health," in which he showed that *Trichina* might be communicated by the dog to man.

Mr. Groom Napier brought forward papers "On the Food and Economic Value of British Butterflies and Moths," and "On the Causes of Variation in the Eggs of British Birds."

Mr. Frank Buckland amused the Section, as is his custom, by a jocose description of Salmon and Oyster fisheries.

In Human Anatomy there was but one paper, but that was of considerable interest, being "On Variations in the great Arterial Blood Vessels," by Dr. G. D. Gibb. The author illustrated the subject by two examples. In the first, the large vessel rising from the heart, called the aorta, gave four branches instead of the usual three, the right carotid and the subclavian, both rising by a distinct and separate trunk, there being necessarily an absence of the innominate artery. In this curious case there was an irregularity in the division of both femoral arteries and in the left sciatic nerve. In the second example, the aorta divided into two great branches; the first of which subdivided into the usual innominate and the left carotid, which crossed the wind-pipe to the left side. The second branch divided into the left carotid and descending aorta. With regard to the first example it had occasionally been met with by anatomists, but the second the author considered unique, the most experienced observers having failed to record anything similar. He considered this variation in the larger blood vessels as a deviation from the standard or well-recognized ordinary type, and to some extent a precursor of similar conditions in the lower animals. Their occurrence, however, could not be determined during life, nor could any special deduction at present be drawn from them. In the first example, the blood vessels of the extremities had become converted into what might be popularly called cylinders of bone, examples of which were submitted to the Section. Dr. Gibb also illustrated his paper by some well finished drawings.

The papers bearing on the subject of Distribution were very numerous, but have very little interest at present in an isolated form, beyond the bare facts expressed in their titles. Mr. Gwyn Jeffreys read his report on dredging among the Hebrides; while Mr. H. B. Brady furnished some remarks on the Rhizopod Fauna of those islands; Mr. G. S. Brady reported on the Ostracoda; and the Rev. A. M. Norman gave a list of the Crustacea, Echinodermata, Polyzoa, and Cœlenterata of the same locality. Mr. John Shaw endeavoured to show, in a clever essay, how the distribution of mosses in Great Britain and Ireland was connected with the Geographical and Geological history of the present Flora. The chief points touched on in the paper were of a geological character, such as the gradual glaciation from Miocene periods, breaks in the glacial period, the elevation of land as necessary for the existence of an Alpine, meridian, and southern flora contemporaneously. A similar paper was that by Mr. Hennessy, F.R.S., on the probable cause of the existence of a north European flora in the west of Ireland. Mr. John Hogg, F.R.S., read a paper on the ballast flora of the coasts of Durham and Northumberland; and Mr. Moggridge noticed the occurrence of *Lemna arrhiza* in Epping Forest, and furnished a paper on the zones of the coniferæ from the Mediterranean to the crest of the maritime Alps. Dr. Perceval Wright read some notes and exhibited specimens derived from a botanical tour in the islands of Arran, West of Ireland.

Two papers were read in which the object of the author was to account for certain phenomena by the aid of the theory of natural selection, hence dealing with the "reason why" they would come under Professor Huxley's definition of Physiology in its broad sense. One was a short note by Dr. Perceval Wright, on a moth, *Lithosia caniola*, which occurred in a single bay in the county of Dublin. It had been supposed that this form was introduced by smuggling vessels from the coast of France where it occurs; but Dr. Wright was of opinion that it was the peculiar climate and condition of the bay which favoured its appearance, or production by natural selection. He had hence been much gratified by discovering the same moth in a bay of identical character, on the south-west coast of Ireland. The other paper alluded to was by Mr. Wallace, the well-known investigator of the Amazons and Malay Archipelago, on Reversed Sexual Characters in a Butterfly, and their interpretation on the theory of modifications and adaptive mimicry. Specimens of the butterflies were exhibited. The *Heliconidæ*, a group of Lepidoptera with an offensive odour, were never taken by birds as food. Whenever they appeared, butterflies of another group accompanied them, the females of which closely resembled the obnoxious Heliconidæ in colour, and hence were avoided by birds, and were able to deposit their eggs and perpetuate their race. Mr. Wallace contended that this imitation could alone be accounted for by the greater immunity which butterflies resembling the Heliconidæ even in a small degree would always possess, the resemblance thus becoming greater and greater in each succeeding generation, by the destruction of those in each brood which bore the least resemblance.

Two papers were read which had reference to the practical application of Biological Science to social economy. Mr. Thomas Browne read a short paper, in which he inveighed against the use of Latin nomenclature and Anglicized Latin, advocating the German plan of using the vernacular, as tending to increase the diffusion and comprehension of scientific truths amongst uneducated persons. A much more valuable paper was that of the Rev. W. Farrar, of Harrow School, "On the Teaching of Natural Science in Public Schools." He expressed his conviction of the necessity and desirability of extensive education in physical science. At Marlborough, Rugby, and Harrow efforts had been made in introducing these studies, and the results of the various methods adopted were compared. He proposed to remove that useless and overwhelming tax on a boy's powers of study, *viz.* verse making, and would substitute some branch or branches of physical science. He felt sure that the masters in our public schools were much in earnest in this matter, and only needed encouragement. Dr. Hooker considered chemistry as too rigid a study for a young boy to commence with, and thought botany and zoology should be the first studies. Professor Tyndall had often witnessed the deep interest boys took in the study of physics, when properly opened to them. The habit of verification by experiment, and the consciousness of a power of prediction, were most important characters to implant in the mind; but this could only be done by a true and philosophic study. Mr. Payne charged men of science with talking in this matter and not acting. They would not come forward and teach, and they alone could teach as was necessary; hence the slow progress which the movement made. Professor Huxley felt sure that if all men should be as earnest as Mr. Farrar they had nothing to fear. The important question for England just now was not as to her supply of coal, but the necessity of education in the great truths of science.

In the department of Physiology, Dr. Humphry delivered an address opposing the law of Continuity in Life, and Darwinism. Dr. Humphry believes in heterogenesis, subject to certain laws. Dr. John Davy, in a short paper, advanced the view that the carbonate of lime in the egg-shell of birds exists in an amorphous condition. Mr. C. Stewart maintained that the minute aggregations composing the shell had a clearly radiated crystalline structure. A letter was read from Dr. Acland, announcing the refusal of the Medical Council to apply a sum of money to the investigation of the physiological action of medicines, and a paper on this subject was read by Dr. Sharp. Dr. B. W. Richardson reported on the action of Amyl, and exhibited his method of producing local anæsthesia by ether vapours on the person of the President of the Association, into whose arm he stuck needles, &c., without any pain being occasioned. He also read an essay on the Comparative Vitality of Jews and Christians, in which, after adducing a large number of statistics, he offered the conclusion that the great vitality of the Jews is owing to their temperance, faithfulness, cleanliness, and prudence,—not to any traditionary hygienic law or race-characters.

Dr. Spencer Cobbold read papers on the Cattle Plague, Entozoa, and on experiments with Entozoa.

Dr. Gibson made some observations on the movements, structure, and sounds of the Heart; and Dr. Norris read a very long essay on Muscular Irritability and the Relations which exist between Muscle, Nerve, and Blood.

One of the most original and satisfactory papers in this department was by Dr. Arthur Gamgee, "On the Action of Carbonic Oxide on Blood." Dr. Gamgee had followed up Professor Stokes' observations on the spectra of arterial and venous blood. He had found in experimenting with carbonic oxide, that it forms with the colouring matter of the blood a stable compound, having much resemblance to the dark form of cruorine in its absorption bands, but differing from that body in its stability. The hæmato-globuline of blood, when thus combined with carbonic oxide, did not coagulate; hence it was that persons poisoned by charcoal fumes are found to have their blood in a non-coagulable condition. Acetic acid poured upon such blood set free carbonic oxide, and produced coagulation.

Mr. W. L. Scott read a paper on the presence of Ammonia and its Homologues in the Blood, supporting Dr. Richardson's theory of coagulation. The other papers read in this department were, Dr. Foster, "On a peculiar Change of Colour in a Mulatto;" and, "On an Addition to the Sphygmograph."

The Anthropological subdivision of Section D has done much to restore that branch of science to public favour, and the Committee of the major section showed great wisdom when they invited the eminent traveller, Mr. Wallace, to become its President.

Mr. Wallace delivered a short address, characterized by modesty, conciliation, and liberal sentiment. He claimed for Anthropology the function of inquiring into the nature of Man in all its aspects. His physiology, his anatomy compared with that of the lower animals, his history and palæontology, his psychology, his geographical distribution, his archæological traces, and the study of his skull, brain, and languages, are all included in the noble science of Anthropology; and it is the province of Anthropologists to collect, combine, and systematize all facts bearing upon these questions.

"We cannot afford," he said, "to neglect any facts relating to man, however trivial, unmeaning, or distasteful some of them may appear to us. Each custom, superstition, or belief of savage or of civilized man, may guide us towards an explanation of their origin in common tendencies of the human mind. Each peculiarity of form, colour, or constitution, may give us a clue to the affinities of an obscure race. The Anthropologist must ever bear in mind, that as the object of his study is *man*, nothing pertaining to or characteristic of man can be unworthy of his attention.

"It will be only after we have brought together and arranged all the facts and principles which have been established by the various special studies to which I have alluded, that we shall be in a condition to determine the particular lines of investigation most needed to complete our knowledge of man; and may hope ultimately to arrive at some definite conclusions on the great problems which must interest us all—the questions of the origin, the nature, and the destiny of the human race.

"I would beg you to recollect also, that *here* we must treat all these problems as purely questions of science, to be decided solely by facts, and by legitimate deductions from facts. We can accept no conclusions as authoritative that have not been thus established. Our sole object is to find out for ourselves what is our true nature—to feel our way cautiously step by step into the dark and mysterious past of human history—to study man under every phase and aspect of his present condition; and from the knowledge thus gained to derive (as we cannot fail to do) some assistance in our attempts to govern and improve uncivilized tribes, some guidance in our own national and individual progress."

Strangely enough, this is the first time that the study of man's nature and history has, in modern times, been viewed in its true character, and "Anthropologists" cannot do better than to stick closely to the principles laid down by their new leader.

Amongst the papers read in this Section subsequent to the President's Address the following are worthy of note:—

Mr. Carter Blake described a human jaw from the Belgian bone caves, which was discovered near Dirant by the Government officials. It was found in undisturbed sandy clay, at a depth of $3\frac{1}{2}$ metres (11 feet 4 in.), the clay alternating with stalagmite, and affording evidences of gradual deposition. The characters which it presented were very different from those exhibited by the jaws of the white races of the present day, and presented in many points an exaggeration of the characters of the lowest Australian jaws. Doubts were expressed by some members of the Section as to the authenticity of the "find," but the President regarded it with great interest.

Professor Huxley read an interesting paper "On two Extreme Forms of Human Crania:" one, that of a Tartar from the Museum of the Royal College of Surgeons; the other, said to have come from New Zealand. The first presented the extreme characters of the brachy-cephalic type, its breadth being 977·1000 of its length; the other was remarkable for its length, which bore to its breadth the proportion of 1000 to 629. In the discussion which followed the paper Dr. Turner stated that he had two skulls, one a Bohemian, the other from Lincolnshire, which in many respects resembled those now exhibited. Mr. Carter Blake expressed the view that artificial pressure had caused the extreme narrowness of the New Zealand skull, and Dr. B. Davis also attributed the extreme measurement of the other skull to artificial causes.

Dr. James Hunt read a paper "On the Cranial Measurements and Personal Attributes of 98 Examples of Norwegians," and pointed out attributes which rendered it undesirable to confound the inhabitants of Sweden with those of Norway.

With regard to the indications of the ancient races by their weapons, &c., some noticeable papers were contributed. Mr. J. W. Flower described a Kjökken-mödding, which he had discovered in the island of Herm, opposite to Guernsey. The shell mound contained bones, &c., and some curious fragments of pottery used for grinding. Sir Edward Belcher exhibited some very curious stone implements belonging to the Esquimaux, which tended to throw light on the uses of the ancient implements now so much discussed.

Professor Tennant described an Irish Lake Dwelling, discovered by Captain L'Estrange. It appears that lake dwellings existed in Ireland as late as the time of Cromwell; they are also made mention of by the poet Spenser.

Of papers on particular races there were the following:—

Dr. John Beddoe, "On the Stature and Bulk of the Irish." Mr. Bogg, "On the Fishing Indians of Vancouver's Island." Mr. J. K. Lord on the same subject. Consul Hutchinson, "On the Indians of the Paraña." Mr. Collinson, "On the Indians of the Mosquito Territory." Dr. Charnock, "On the People of Andorra." Dr. Gustave Lagneau, "On the Saracens in France." Mr. Ernst "On the Anthropology of Caracas." Dr. Short, "On the Marvar Tribes of India." Professor Leitner, papers from Lahore. Dr. Paul Broca, "On the Anthropology of Lower Brittany." Dr. Mann, "On the Zulu Kaffirs of Natal;" and Mr. Haughton, "On the Land Dayas of Upper Sarawak." Papers of a more comprehensive and philosophical character were those of Mr. Tylor, "On the Phenomena of Higher Civilization traceable to a Rudimental Origin among Savage Tribes," in which the author showed that the most important explanations of present or past unaccountable manners, customs, and superstitions may be obtained by the study of comparative mythology, and by seeking evidence among present savage nations of old customs or superstitions in a modified form. That of Mr. Phillips Day, "On the Power of Rearing Children among Savage Tribes;" and that of Dr. Hunt, "On the Principle of Natural Selection," applied to Anthropology.

The meeting at Nottingham, as far as Section D was concerned, was a successful one, as is shown by the very large number of papers read, all being of a high standard as regards scientific worth, though none were exceptionally, and a few were perhaps not generally, interesting.

We greatly regret that our limited space has prevented us from giving little more than the titles of many interesting papers on those branches of Science included under the general head of Biology, but our readers will readily perceive, from the very scope of the subject, that it is hardly possible to do justice to it in a short summary.

Geography and Ethnology. (Section E.)

The new arrangement decreed by the Council of the Association last year, whereby the science of Man was referred to the Natural History Section and powers given to that Section for the constitution of a department of Anthropology, has not yet had the effect of lessening the number of papers usually read in the Section of Geography and Ethnology. By the new arrangement, all papers treating of the Zoological characters, origin, and primitive history of man are, or ought to be, discarded from the Section which treats of pure Ethnology, and those papers only admitted which describe the observations of travellers on the tribes of distant countries, chiefly in their geographical relations. One or two papers however were read which the Committee of the Section ought, perhaps, not to have admitted. The Section sat six days, and several papers on the programme were left at the last unread.

A trio of famous travellers constituted the chief attraction of the meeting; the names of Baker, Palgrave, and Du Chaillu on the lists of authors of papers drawing together very large audiences. It was computed that 1,200 people were assembled to hear (or, perhaps, rather to see) the gorilla hero; the audiences drawn by Sir Samuel Baker and Mr. Palgrave being somewhat inferior in numbers. The other geographical papers were much inferior in popular interest to the discourses of these three travellers, but there were several of much scientific value and geographical novelty. We will now proceed to give a sketch of the principal subjects brought before the Section.

Sir Samuel Baker commenced the scientific work of the Section, on Thursday the 23rd, by a discourse (it was not a written paper) on the "Relations of the Abyssinian Tributaries of the Nile and the Equatorial Lakes to the Inundations and Fertility of Egypt." Sir Samuel showed himself to be a ready speaker, and the skilful way in which he combined graphic description and amusing narrative with closely-reasoned argument, produced a great effect on his audience. His object was to show, from his own observations, that the annual inundations and fertilizing mud of the lower Nile Valley were produced solely by those tributaries of the great river which have their rise in Abyssinia, and that the outflow from the great lakes near the Equator had simply the effect of keeping up the supply of water when the Abyssinian floods ceased in the dry season. He spent twelve months, from June 1861 to June 1862, in exploring the Abyssinian streams, ascending the banks of the Atbara, and from its upper waters crossing the tributary rivers till he reached the Blue Nile, down which he travelled to Khartum. He described the condition of the Atbara when he first reached its banks, at the close of the dry season. The river is the last tributary which the

Nile receives in its course towards the Mediterranean. From its junction the great river flows through upwards of 14 degrees of latitude, or, allowing for the winding of the bed, about 1,100 miles, through deserts of burning sand, where evaporation and absorption dissipate a large proportion of the water it receives from the upper part of its course. At the junction of the Atbara, the volume of the Nile water is at its maximum. When Baker travelled along the lower part of the course of this important tributary it presented a dry sandy bed, fringed with a few Doum palms and mimosa bushes; not one drop of water flowed from it to the Nile. He proceeded for about 180 miles, and then, on the 23rd of June, witnessed the sudden change which transforms this desert bed into a vast river. The deluging rainfall had commenced in Abyssinia, and the flood came down so rapidly that in a few hours the Atbara, here 500 yards wide, had become a noble stream 20 feet deep. When he had reached the Settite, the principal affluent of the Atbara, which, being situated in a more humid climate, never becomes wholly dry, he discovered the source whence the fertilizing deposit is derived which the Atbara carries down towards the Nile Delta. The country is table-land, covered with rich mould, and the rains sweep this into the streams in such quantity that in the height of the flood the waters of the Atbara become of the consistency of soup.

When sailing up the White or main Nile *en route* to the Equatorial lakes, Sir Samuel observed the great contrast which the river presented to the tributaries he had just visited. He gave a brief outline of his journey from Khartum to the shores of the Albert Lake, and showed that whilst in Abyssinia the rainy season lasts only three months, from June to September, the region of the great lakes has a ten months' rainfall. The outflow from the Albert Nyanza is therefore perennial; it keeps up the supply to Egypt when the Abyssinian inundation has ceased, and prevents the lower Nile from becoming a desert; the supply, moreover, is sufficiently great to overcome the great absorption and evaporation which intervene in flowing through the Nubian deserts. It does not however carry any considerable quantity of fertilizing deposit towards the Delta. Sir Samuel might have here quoted, in support of his views, the authority of Dr. Peney, who made careful measurements of the fluctuations in the Nile-level at Gondokoro, and discovered that there was no regular annual flood and subsidence, but numerous minor fluctuations at intervals of a few days.

Sir Samuel also communicated his ethnological observations to the Section on the last day of the meeting, Wednesday the 29th. It was again an unwritten discourse, and given with a graphic power and humour which delighted the audience. The title given in the programme was "Observations on the Negro Character;" but this gave an inadequate idea of the theme, which was "The

Tribes of Central Africa as influenced by Local Conditions." He gave his observations in the form of a narrative, commencing with his first meeting with true negroes, in sailing up the Nile, in 15° N. lat. All tribes to the north of this were of Semitic derivation, or mongrels of various intermixture. He described the wretched condition of the Aliab, Shyr, and other tribes who inhabit the vast region of morasses extending on either side of the White Nile between 10° and 5° N. lat.; naked savages of emaciated forms and the lowest type of negroes physically and morally. In these regions there was no iron ore or dust and therefore no iron manufacture, one of the causes of the superior condition of the tribes on the higher lands. They are always in a state of semi-starvation, and are driven to grind the bones of animals between stones to make soup of. Among the tribes of the higher lands between 4° N. lat. and the equator, the art of working in iron is everywhere practised, and instruments of great beauty are manufactured. The Unyoro people have even invented a kind of hoe, so ingenious that it might be copied to advantage by Europeans. In those parts of the country, again, which are adapted for cattle, the tsetse fly has great influence; the fly is restricted to certain circumscribed localities; wherever it is present there can be no cattle, and the people are inferior in civilization; wherever it is absent the condition of the people is entirely changed; for the protection of their wealth in cattle necessitates warlike organization and elevates the social character in many other ways. Notwithstanding the many points of difference, the general character of all the tribes was the same. Sir Samuel reiterated that the first step necessary to the improvement of the Central African tribes, was the abolition of the present slave traffic; and that an extensive commerce might be carried on between Europeans and the superior tribes dwelling in the region of the great lakes if this step were taken.

Mr. Palgrave's paper was on the two divisions of Arabia, North and South. He endeavoured to impart some novelty to a subject on which he has already written and lectured so much, by describing in a clear form the physical and social characteristics which distinguish Nejed, the country of Wahabee domination, from Oman, the region which is becoming of growing importance to us.

M. Du Chaillu's paper was entitled "Notes on the Physical Geography and Tribes of Western Equatorial Africa." The subject was generally thought to be ably and scientifically treated; and the audience seemed to be surprised, if not disappointed, that they were not treated to gorilla anecdotes and travellers' tales. The author gave a general description of the country he had traversed during his last journey, showing that with the exception of a belt of low coast land about 80 miles wide, it consisted of a hilly region covered with primitive forests. The land successively rose as he ascended the hilly ranges which run nearly parallel to the coast, until, 250 miles from the coast, it reached an altitude of 2,500 feet above the sea level. The forest is so continuous that the small tracts of prairie land seemed like islands in a sea of foliage. Nearly all the quadrupeds characteristic of Africa were absent, lion, rhinoceros, giraffe, zebra, ostrich, eland, &c., whilst several apes were peculiar to the region, including the gorilla.

An important paper was read on Monday the 27th, "On a Recent Expedition from Leh to Khotan, in Chinese Tartary." The author was Mr. W. H. Johnson, one of the civil assistants in the Great Trigonometrical Survey of India. This great survey properly terminates in North-western India, at the Karakorum range of the Himalaya; the officers engaged, however, on carrying their triangulations to the summit of these passes, naturally cast a longing eye over the forbidden ground beyond, a region of which nothing as yet is accurately known. Mr. Johnson had the boldness to adventure into this unknown land. He crossed, northward of Leh, the pass of Lumkang (19,533 feet), and reached the elevated plateaux which extend between the Karakorum and the Kiun Lun ranges of mountains. The first plain is about 17,300 feet above the sea level, and bears traces of having been the bed of a large lake; a second plain slopes for a distance of 30 miles, in a north-easterly direction, from 16,700 feet down to 15,300, when it rises again towards the watershed of the Kiun Lun. He struck the Karakash river of Tartary at a point where it is 15,500 feet above the sea-level. Great plains stretched hence towards the east and south-east, but to the west lay a series of deep valleys. Beyond this point Mr. Johnson travelled under the protection of the Khan Badsha of Khotan, who, having shaken off the yoke of the Chinese, was anxious to cultivate friendly relations with the British Government, and invited the adventurous surveyor to visit him in his capital, Ilchi. He sent an escort to meet him, and the march was resumed into the plains of Tartary. It took him sixteen days to travel from the Karakash to Ilchi. He met there with a most friendly reception, and made excursions into the neighbouring country. The city contains a population of 40,000, and is the seat of many manufactures and a busy trade. It is 4,329 feet above the sea-level. At a distance of six miles to the north-east of the city commences the great desert of Gobi, with its shifting sands, which move along in vast billows overpowering everything. The sand is an extremely fine dust resembling pulverized clay, and when it moves the whole atmosphere becomes so dark that Mr. Johnson, at Ilchi, was obliged to use a candle at mid-day to read large print. Where the dust falls it fertilizes the soil, and the province of Khotan is so much enriched by it that the district is more productive than the valley of Kashmere; cotton, silk, and fruits are produced in great quantities, and Mr. Johnson considered the country far superior to India. Khotan is watered by numerous affluents of the Tarim river, which discharges itself into the great lake Lob Núr; canals have been dug from stream to stream for the irrigation of the country. The return journey was made in November, 1865. The elevated plateau between the Kiun Lun and Karakorum ranges was then in its winter garb, and the cold was so intense that the beards of the party were covered with icicles whilst travelling in the sun. He crossed the Karakorum pass (18,317 feet), and reached Srinagar, the capital of Kashmere, on the 19th December.

The discussion which followed the reading of this remarkable paper was rendered interesting by the part taken in it by Dr. T. Thomson, the well-known Himalayan traveller and botanist, who was the first Englishman who ascended to the summit of the Karakorum pass. Sir Andrew Waugh, late Surveyor-General of India, who read the paper, stated that it was accompanied by an excellent map of the new region surveyed by its author, photo-zincographed from his plane table.

A paper relating to the Pangong lake in the elevated region of Ladakh, lying in the route of Mr. Johnson, from the pen of Captain Godwin-Austen, was also read to the Section, and gave a detailed account of the physical geography and glacial phenomena of the neighbourhood.

The Section was rich in papers on physical geography, for besides the cummunication of Captain Godwin-Austen just alluded to, there was a remarkable paper by Colonel Tremenheere, on the Lower Indus, which gave in a summary form the results of the author's engineering surveys of the lower course of the river for 540 miles from its mouth. He showed that the Indus flowed along the summit of a ridge, the plain of Sind sloping away from each side of the river as well as downwards towards the sea. The slope of the plain in a direct line to the sea is 9·3 inches per mile, and in many places the transverse slope on each side of the river is quite as much. The soil consists of a very fine silicious deposit, without a single grain of sand as large as a pin-head. The amount of silt carried down annually is sufficient to cover 70 square miles of the sea-bottom with deposit one yard in thickness. It is curious that there exists, in the plain, dry channels far below the actual bed of the Indus; these exist only on the eastern side, and the conclusion must be that the river has gradually worked to the westward. Colonel Tremenheere observed that it might be generally stated of rivers flowing through such plains, that the larger the body of water and the less the surface slope of the plain the more direct will be the course of the river; and, on the contrary, the sharpness of the bends of a large river flowing through such a plain will indicate the existence of a considerable slope. The longer a river becomes by extending its delta into the sea, the greater tendency will there be to assume a more direct course. The paper was accompanied by elaborate plans and sections, and contained numerous details and pregnant generalizations which render it of high value. It will probably be read and discussed at an evening meeting of the Geographical Society during the ensuing session.

Another paper of the same class was read by Mr. Markham, "On the Aleppy Mud-bank in South-Western India," showing the existence of a subterranean passage for the fine silt impelled by the back-waters of this part of the coast, under the belt of coast land, into the sea. There was also a physico-geographical paper by Professor Ansted "On the Peninsula of Taman and the Eastern part of the Crimea," which described a line of mud volcanoes at Taman recently visited by the author, and showed that these volcanic outbursts, which changed the geographical outline of this district, formed part of a line of up-heavals which extended a distance of 1,000 miles, and were the remains of the ancient line of elevation when, after the glacial epoch, the regions to the north were raised above the level of the sea. An interesting paper was also communicated by Commander Lindsay Brine "On the Volcanic Eruptions at Santorin," the progress of which he had himself witnessed. He gave the result of soundings in the crater-harbour of the island, which showed how limited was the area of sea-bottom affected by the volcanic disturbance.

Reverting to Africa, there were several papers on different portions of this continent, so fertile in subjects of geographical and popular interest, besides those of Baker and Du Chaillu. Dr. Mann, the Superintendent of Education at Natal, read two papers, which were listened to with great attention, one "On the Physical Geography and Climate of Natal," and the other "On the Kaffirs." Dr. Mann has been for eight years a resident in Natal, and showed himself to have been a close observer, both of its physical phenomena and of the character of its indigenous inhabitants. He gave a very clear sketch of the peculiar configuration of the colony, its land frontier of mountain ridges rising to an average height of 5,400 feet, with their projecting spurs, each having minor spurs in pinnatifid form, graduating in level towards the sea, so that the surface of the land has a gradient from the sea upwards of 1 in 70. Between each ridge lies a deep valley through which flows a stream, and no less than 50 distinct rivers find their way to the sea along 150 miles of coast. Meteorological tables and diagrams were exhibited, and the climate described as a subtropical one, but softened in its character, the hot season being tempered by daily rains and clouds, which commence in the morning as soon as the sun has gained power, and the cool season attended by clear sunny skies and cold nights. He gave statistics showing the growing productiveness of the colony. Of the Kaffirs he spoke most encouragingly, and gave instances of steady industry, accumulation of property, and appreciation of education among them.

Mr. Thomas Baines read two papers, one "On the Westernmost Branches of the Zambesi," and another "On the Lower Course of the Limpopo," pointing out where further explorations are needed. Dr. Beke also read two papers on African subjects, one "On the Possibility of Diverting the Waters of the Nile into the Red Sea," and one "On the Lake Kura of Arabian Geographers." He quoted numerous historical authorities, and a modern traveller, Schweinfurth, to show that the fertilizing waters of the Atbara might, by the formation of dams, be turned into the Gash, the present dry lower channel of which trends in the direction of the Red Sea. Sir Samuel Baker, in the discussion which followed the reading of this paper, emphatically denied that the bed of the Gash extended to the Red Sea, and stated that there existed no natural facilities for the diversion of the Nile waters. With regard to Lake Kura, which had been placed by Arabian cartographers south of the equator in the position of the newly discovered lakes, Dr. Beke showed that it was no other than the marsh-lake near the junction of the Bahr el Ghazal and the White Nile in 90° N. lat. A paper was also read "On a Recent Visit to Vohimarina," the north-eastern province of Madagascar, by Dr. Ryan, Bishop of Mauritius, describing the harbours, the fertile valleys between the mountains, and contrasting favourably the Betsimsaraka race of that part of Madagascar with the dominant Hovas.

A very interesting paper was read by Mr. R. H. Major "On Priority in Discovery of the Madeira Group," in which the author showed, from the examination of unpublished documents, that the islands were first discovered by Genoese in the first half of the fourteenth century; in proof of which he quoted a map of the date 1351, now existing in the Laurentian library at Florence, in which the group is laid down with its present names. The names were therefore not originally given by the Portuguese in 1418–20 as generally believed. Mr. Major also stated that he had found additional evidence in support of the romantic accidental discovery of Madeira by the Englishman Machim, in a Portuguese manuscript now at Munich, earlier by half a century than the earliest printed account of that adventure.

Besides the papers already mentioned on Asiatic subjects, there were three read to the Section of considerable interest and importance. One was by Colonel Goldsmid "On a Recent Journey through Eastern Persia and Western Beloochistan," which the author had undertaken in carrying out his duties as surveyor of the new line of the Indian telegraph. Another was by Mr. J. Thomson "On a Recent Visit to the Ruined Cities and Temples of Cambodia."

The third remaining paper on Asiatic subjects was "On the proposed Ethnological Congress at Calcutta," by Sir Walter Elliott. Sir Walter stated that a project had been formed in Calcutta for gathering together, during the great exhibition proposed to be held in 1869–70, living examples of all the races of man of the old world, for Ethnological study; and that a second minor scheme had also been entertained for an assemblage of specimens of the distinct tribes of the Bengal Presidency, to take place at an earlier period. He proposed, himself, a third scheme, intermediate between the two, as more practicable than the first and more widely useful than the second; this was an assemblage of living examples of all the distinct tribes living in British India. He enumerated some of the curious specimens which would, on this plan, be brought to Calcutta, and gave some details of tribal peculiarities. He hoped that European ethnologists would avail themselves of the advantages the proposed congress would offer for the comparison, side by side, of so many types of man.

There were six Ethnological papers read in the Section, besides those already mentioned. Some of these dealt only in generalities, and offered little that need be remarked upon in this place. Two were by the veteran Ethnologist, Mr. J. Crawfurd, on "Julius Cæsar's Account of Britain and its Inhabitants;" and "On the Migration of Cultivated Plants, with reference to Ethnology." They were characterized by the clearness of statement and acuteness of observation which distinguish the venerable President of the Ethnological Society. In the second paper, he advanced the proposition that no tribe or nation ever emerged from the savage condition without the possession of cultivated cerealia, and seemed to imply that it was the nourishment obtained from these grains that influenced the character of nations.

A discussion followed the reading of the paper, in which Mr. Nash and Mr. C. R. Markham showed that the argument did not hold good in some cases. Mr. Nash instanced the ancient Britons and Irish as depending more upon milk and cheese than upon grain; and Mr. Markham showed that the civilized Peruvians of the elevated table-lands around Lake Titicaca lived upon roots, a diet which according to Mr. Crawfurd condemned the tribes that were confined to it to the lowest grade of culture.

The remaining papers on Geographical subjects were one by

Mr. G. Grove, entitled a "Report on the First Expedition of the Palestine Exploration Fund," which has already been made public, and two short notices by Mr. W. Webb and Sir Roderick Murchison; the former giving an account of Dr. Livingstone's recent progress on the Rovuma river, and the latter communicating the welcome news that the remains of the unfortunate Leichhardt expedition had been at length discovered by the search expedition now on its march in the interior of Australia. No details had at present arrived in this country, and the news had only been received during the Association week by Sir Roderick from Dr. Mueller, of Melbourne.

H. W. B.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

The Cattle Plague—which at the beginning of the past quarter was rapidly declining, still however attacking several hundred fresh cases every week—has at length dwindled to very insignificant proportions; and, excepting for its extreme infectiousness, it is no doubt of less account at present than many other fatal disorders to which the live stock of the farm are ordinarily liable. The returns for the weeks ending Sept. 1 and 8 recorded only 99 and 69 attacks respectively in all Great Britain. Upwards of a quarter of a million cases had occurred during the 52 preceding weeks, of which nearly one-half had died and one-third had been slaughtered, leaving, with a certain number unaccounted for, less than one-sixth as the proportion of recoveries. The third and final report of Her Majesty's Commissioners was published in the month of June, and with the accompanying discussions of all the aspects and relations which the subject presents, it constitutes a perfectly exhaustive treatise on the disastrous experience of the past twelvemonth, which all stockowners should study. In particular, the question of disinfection, which it examines, possesses a permanent interest. This has been most elaborately investigated by Mr. Crookes and Dr. Angus Smith, whose researches are given in full detail. The following is the result of their inquiry as stated by the Commissioners:—

"It is evident that the poison ought to be destroyed at the very moment of evolution or discharge. The disinfectant must therefore not only be both fixed and volatile, but so cheap and easily used as to be continually in action, and it must of course be innocuous to cattle and men.

"A large number of substances which can be used in many other cases as disinfectants must be put aside, as not meeting these necessary conditions. Compounds of iron, zinc, lead, manganese, arsenic, sodium, lime, or charcoal powder, and many other substances, want the volatile disinfecting power; iodine, bromine, nitrous acid, and some other bodies are too dear, or are entirely volatile, or are injurious to the cattle.

"On full consideration, it appears that the choice must lie between chlorine, ozone, sulphur, and the tar acids (carbolic and cresylic). Two of these bodies, *viz.* chlorine, in the shape of chloride of lime and the tar acids, have the great advantage of being both liquid and aeriform; they can be at once added to discharges, and constantly diffused in the air.

"All these four substances—chlorine, ozone, sulphurous acid, and the tar acids—have been practically tested, either in England or on the Continent, and there is considerable evidence that they all actually do destroy the cattle plague poison. Their precise mode of action is still uncertain. Chlorine and ozone act, no doubt, as powerful oxidisers, converting animal poisons into simple and innocuous substances. Sulphurous acid probably destroys the virus by its strong antiseptic powers. The tar acids, according to the experiments of Mr. Crookes, neither interrupt nor accelerate oxidation, but they act most powerfully in arresting all kinds of fermentative and putrefactive changes, and annihilate with the greatest certainty all the lower forms of life.

"After a full consideration of the relative merits of the four disinfectants, and after some practical trials, Mr. Crookes arrived at the conclusion that the most powerful, and at the same time most simple, process of disinfection would be to use the tar acids as constant liquid and aeriform disinfectants, and sulphur in the form of sulphurous acid as an additional and occasional agency.

"For the reason stated in Mr. Crookes's report, it appears that chloride of lime is inferior to the combined use of carbolic and sulphurous acids. But there is no doubt of the efficacy of this agent, and in certain circumstances, as for the washing of railway trucks, it may be employed in addition to boiling water or steam.

"It is very desirable that the use of carbolic acid should become general throughout the country in uninfected as well as in infected districts. There is little doubt that even were there no danger from the cattle plague, the great purifying effect of this substance on the air of cattle sheds would contribute greatly to the health of the animals."

We presume that a very long experience of the use of carbolic acid is necessary before its permanent efficiency can be determined; but in the mean time its cheapness, easy applicability, and power of at once arresting all kinds of putrefactive change, doubtless justify all that the Commissioners say in its favour.

In connection with this subject we have to add that all attempts, arising out of this national calamity, to establish a National Insurance Society and Fund have failed. Dr. Farr, F.R.S., did, indeed, read a paper last June before a meeting of the English Agricultural Society, advocating a plan which he had drawn up, by which the whole live stock of the country might have been insured by Government upon the voluntary principle; but no action followed upon it. To establish such a society, the first thing necessary was that noblemen and gentlemen interested in agriculture should subscribe to a guarantee fund, on the plan adopted at the

Great Exhibition, and it was proposed that Government should subscribe an equivalent amount, engaging to advance money for preliminary expenses at a moderate rate of interest. The guarantee fund was intended only to make advances or loans, and the subscriptions were to be called for by instalments only in cases of necessity. An appeal should be addressed by the Statistical Department of the Privy Council to all the principal stock owners of the kingdom, requesting their concurrence. The concurrent stock owners would then be requested to send in classified lists of their stock and its value. The premium to be demanded would have to be sufficiently high to cover the risk, and it was believed that 1*s*. per month would insure 10*l*. on a healthy beast exposed to ordinary risks under good arrangements. No beast worth less than 5*l*. should be insured. The policy might be transferred on the sale of cattle being registered. Horses and sheep might be insured upon terms to be agreed upon. Payment of premiums might be made through the post-office. All payments on policies might be made on the authority of a specially-appointed officer in every county, acting under the inspection of the committee. The accounts should be duly audited and published annually, with a digest of the returns and report made by the actuary, to be appointed by the Home Office. All cattle imported diseased should pay adequate premiums, and if healthy, receive policies covering a term of one month or more; the premium in such cases to be collected by the officers of her Majesty's Customs, and paid by them on account of the Society into the Bank of England. No person having cattle uninsured should under any circumstances receive compensation from any public rate. Landlords, for their own protection, might insist upon the insurance of stock, and clauses might be inserted to that effect in the leases or covenants. Under these encouragements it was probable that half the live stock in the kingdom would be insured. This would give an amount of 2,000,000*l*. or 3,000,000*l*., which would be sufficient to cover all losses and expenses, and whatever profits might accrue should be divided among the insured upon the mutual principle.

These were the main features of the plan; but we fear, with Mr. Torr, who followed Dr. Farr at the meeting in question, that nothing of a purely voluntary character has any chance of being taken up by the farmers of the country on a sufficiently large scale to ensure its success. The occurrence of a great calamity of this kind is so new, and has been so rare, that the lesson of self-preservation which, were it to be of frequent recurrence, it must ultimately teach cannot be expected to be learnt at once.

To turn to the vegetable world, we have in the first place to report the marked success of the Metropolis Sewage Company in growing great crops of Italian rye-grass upon sheer sea-sand.

About 4,000 cubic yards of the sand below Shoeburyness, which is to be the ultimate outfall of the North London sewage culvert, has been spread over an acre of land near Barking. The surface was sown with Italian rye-grass in February last, and the sewage water allowed to trickle over it. Since then several heavy crops have been cut, one of which, grown in a month's time, weighed about ten tons per acre. The efficiency of town sewage, as a feeder of luxuriant vegetable growth, is being tested at other places near the present North London culvert. Mr. Westwood and Mr. Adams, at East Ham, have ten-acre plots which are yielding enormous growths of Italian rye-grass; and at Lodge Farm, near Barking, the Sewage Company are laying down a large extent of land for surface irrigation, so that in a year or two we may hope to see all South Essex convinced of the enormous fertilizing power which is about to be distributed through that district.

The weather of the past summer has been more favourable for succulent growth, such as that of Italian ryegrass, than for the ripening of seeds, and thus we have to report unfavourably of the harvest. A large proportion of recently published reports of the wheat crop declare it to be below an average, and the extremely wet weather of September has much injured grain crops in the later districts.

One other matter of some agricultural interest may be referred to in this Chronicle. The National Agricultural Societies, both in England and Scotland, are trying by means of paid commissions to ascertain with accuracy the experience of farmers in steam cultivation. As the sum of one thousand pounds has been voted for the purpose by the English Society, we may hope soon to have a full report of the costs and difficulties, advantages and returns, which have been hitherto experienced in connection with the various methods by which steam power has of late been applied to the cultivation of the land.

II. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

During the last few years very close attention has been bestowed by some of our best observers upon the details of the solar surface. The appearance and behaviour of the objects called *willow-leaves*, by Nasmyth, have been observed with especially attentive scrutiny. The variety of names applied to these objects, which have been called *rice-grains* by Stone, *crystals* by Chacornac, *shingle-beach* by Brodie, *coups-de-pinceau* by Secchi, and *corrugations* or *bright* *nodules* by Sir W. Herschel, is sufficient to indicate the propriety of the less distinctive name *granules* selected by Messrs. Dawes and Huggins. Hitherto observation has chiefly been confined to the appearance of the granules on those parts of the sun in which the influence of disturbing forces is apparent, as in the areas of the spots. In these regions only is it that the objects assume that lengthened form from which has been derived the comparison to *straws* or *willow-leaves;* and here only, *if anywhere*, do they present the appearance of interlacing, which has been compared by some observers to *thatching*.

In a paper referred to in the last Chronicle, Mr. Huggins presented the results of some observations of the bright granules on those parts of the sun which are free from spots.

The granules are to be observed over the whole surface of the sun excepting the areas containing spots, and they may be seen occasionally unchanged from their normal figures in the penumbræ and umbræ of spots. Observed with powers of about 100 diameters they present an appearance aptly described by Mr. Stone's epithet rice-grains; but when higher powers are applied the granules present less regularity of figure and size. Besides oval and nearly round granules, irregular masses may be observed. The granules do not appear to be flat discs, but bodies of considerable thickness.

These bodies would appear to average about 500 miles in breadth, and from 500 to 600 miles in length; some however are smaller, and occasionally a granule some 1,000 or 1,200 miles in diameter may be seen. Their distribution over the solar surface is very singular. On many parts of the sun they lie in groups, the components of which are separated by small intervals. These groups vary in form, in some places being round or oval cloud-like masses (mistaken probably for single granules by some observers); elsewhere they are long irregularly formed bands. On one occasion Mr. Huggins observed near the centre of the sun's disc "a long oval border of tesselated bright matter, enclosing an area over which the granules were sparsely distributed." To such groups, and to the varying brightness of the material between groups and granules, the coarse mottling of the solar surface visible when the sun is observed with low powers is to be attributed. Mr. Huggins considers that, except in the penumbræ of spots, the granules are not superposed on each other as long as they remain separately recognizable.

What are these bright bodies? Are they, as their appearance suggests, recently condensed incandescent clouds, or, as Mr. Dawes considers them, merely "ridges, waves, hills, or knolls (or whatever else they might be called)" on the surface of comparatively large luminous clouds? Whence, also, "the general approximate uniformity of size, of form, and of mode of grouping of these incandescent bodies"?

In an essay lately issued M. Chacornac expresses the opinion that the sun is a liquid incandescent mass, surrounded by a dense and imperfectly transparent atmosphere. In this atmosphere solar vapours, raised by evaporation from the liquid nucleus, ascend until they are acted upon by the cold of celestial space, when they condense into luminous crystals. He is of opinion, further, that the sun's spots are caused by the engulfment of vast areas of the photospheric crystals, which lose their brightness as they sink. In this connection we may mention an observation made by Mr. Brodie of "several roundish, isolated portions of luminous matter (having the appearance of icebergs floating on a black sea) in the centre of an umbra."

M. Chacornac discusses, also, the phenomena presented during total eclipses of the sun, Mr. Carrington's discovery that the velocity of rotation of solar spots is a function of solar latitude, and the influence of the planets on the solar atmosphere.

Professor Haughton states that on July 14, 1860, at 2.15 P.M. a meteoric stone fell at Dhurmsalla, the fragments of which were so intensely cold as to benumb the hands of the coolies who picked them up, a peculiarity not easily explicable. The analysis of a fragment sent to the museum of Trinity College, Dublin, presented the following result:—

Chrysolite (peridot or olivine)	47·67
Nickel iron	8·42
Protosulphuret of iron	5·61
Chrome iron	4·16
Minerals insoluble in muriatic acid	34·14
	100·00

Lieut.-Gen. Sabine, Pres. F.R.S., states, in 'Proceedings of the Royal Society,' that from seven years' observations at Kew, compared with observations in other parts of the world, it appears that there is a magnetic variation obviously dependent upon the moon's position relatively to the terrestrial meridian, agreeing in its principal features in various localities. He considers that this variation is "ascribable with great probability to the direct magnetic action of the moon."

In a paper published in the 'Philosophical Magazine,' Mr. Croll has endeavoured to show that the Earth and Moon are approaching each other, and that they will one day be brought together. We have not space to discuss the points raised in this paper, but we believe that the gradual retardation of the Earth's rotation is the only permanent result that can be legitimately ascribed to the action of the tidal wave.

From letters published in the 'Astronomische Nachrichten,' it appears that the new variable star near ε Coronæ must have risen from below the fifth to the second magnitude in less than four hours, if not quite suddenly.

We have to record the discovery of three new planets. On the 16th of May, Mr. Pogson, Government Astronomer at Madras, discovered a new planet, $11\frac{1}{2}$ mag. On the 20th of June, Professor Peters, of Hamilton College, U.S., discovered another of the same size. On the 6th August, M. Stéphan, Director of the Marseilles Observatory, discovered a new planet (in Capricorn), with the new telescope of that Observatory. The planet is of the ninth magnitude, and was observed in Paris the evening after its discovery. Its position on the night of August 7th was R. A. 20h. 52m. 54·23, S. D. 16° 43′ 57″·1, about $\frac{3}{4}$ths of a degree north of the ecliptic. It was retrograding, having lately passed opposition. The numbers of these asteroids will be (87), (88), and (89); Mr. Pogson's has received the name Sylvia; Professor Peters', the name Thisbe.

Proceedings of the Royal Astronomical Society.

In measuring the angles of position of double stars, the most careful observers become aware of a tendency to obtain different results according as the line joining the centres of the stars varies in position. For instance, if the star ε *Boötis* (whose angle of position is about 40° from a declination-circle and 50° from a declination-parallel) is measured (i) when sufficiently *east* of the meridian to bring the components nearly into a vertical line, (ii) on the meridian, and (iii) when so far *west* of the meridian that the components are nearly in a horizontal position, results will be obtained differing always in the same direction, and so pointing decidedly to the varying positions of the star as the cause of the difference. Mr. Dawes explains a simple expedient for determining the amount of error due to such causes, and for correcting results thus affected. This is to be done by placing in an ordinary window-frame a triangular card, having one side vertical and one horizontal, and pierced with holes of varying size, which, taken in pairs, form artificial double stars. These may be viewed with a small telescope, the results of measures taken when the card is placed on one side or the other (of the two at right angles) can be compared, and the existence and amount of error thus determined. Mr. Dawes shows how the necessity for pursuing such a plan of observation for *oblique* positions may be obviated by the use of a small prism "attached to the eye-piece between it and the eye,"—a contrivance which enables the observer to bring a double star in any desired position with respect to a vertical or horizontal line.

M. Otto Struve, after accumulating a large number of double-star measures, became aware of this tendency to error; and to determine its amount and law instituted a series of measures of artificial double stars, set up at a distance from the Pulkova Observatory, and observed with the great equatorial. The results of such observations are of course very valuable, but the plan is clearly not one that can be generally adopted. It becomes important, therefore, to consider whether the objections raised by Struve to the use of the prism proposed by Mr. Dawes are well grounded. Mr. Dawes says, that having for thirty-five years used prisms made by Dollond, Merz, Simms, and Andrew Ross, he has found that no one of them produced sensible deterioration of the image, and that the loss of light is so small that very delicate objects can be observed with this arrangement.

Mr. Pogson presents the results of a series of observations of the planet Mars, with the Madras equatorial and meridian circle. It will be remembered that Major Tennant, Government Astronomer at Madras in 1860, declined (prudently in Mr. Pogson's opinion) to undertake a similar series of observations. The object Mr. Pogson proposed to himself was rather the illustration of the method proposed by Mr. Airy (eight or nine years ago), for the correction of the constant of solar parallax, than the realization of any trustworthy result.

One hundred and fourteen observations were made with twenty comparison stars, between September 22 and October 28, 1862. Owing to the many imperfections of the Madras equatorial, and the low magnifying power employed (63 only), the result was not so satisfactory as Mr. Pogson could have wished, but we think few will agree with him in viewing it as devoid of "any actual value." It affords high evidence of the value of the method proposed by Mr. Airy, and confirms, as far as it goes, the opinion that the long-adopted value (Bessel's) of the parallax requires to be considerably increased. Mr. Pogson's observations give $9''\cdot156$ as the value of the solar parallax. It will be remembered that Hansen, Stone, Leverrier, and Winnecke give, respectively, the values $8''\cdot916$, $8''\cdot943$, $8''\cdot950$, and $8''\cdot964$. Pogson's value differs much less from the mean of these values in excess than Bessel's ($8''\cdot578$) in defect. It is noteworthy that Stone's value is exactly equal to the mean of the four values just named. Adding the two other less trustworthy values, we obtain a mean almost exactly equal to Hansen's.

Mr. Waterston discusses the effects of such a sudden increase of the sun's mass as (in the opinion of many astronomers) seems to be indicated by the sudden blaze of light observed by Messrs. Carrington and Hodgson on September 1st, 1859. He deals first with the opinion some have expressed that the absolute increase of mass must have been small, since the fall of a mass as large as the earth upon the sun would, "from the conversion of its previous mechanical energy, give out such a blaze as would in a moment scorch up all the inferior planets and probably the earth also."* He finds that even if the blaze were persistent, the general rise of temperature would not exceed 15°; but since the extra power of radiation would only act during the short time occupied by the body in passing through the solar atmosphere before plunging under its surface, the blaze would not be persistent. The general temperature of that part of the sun would be very sensibly increased, but the whole potential radiating power of the sun would not be increased in a perceptible degree. And even assuming that this power were increased 1,000°, yet, since the potential temperature which sends heat enough to maintain the earth's temperature (at an average) 500° above absolute zero is about 12,000,000°, the effect would only be to raise the earth's mean temperature $\frac{1}{24}$th of a degree. Therefore, no perceptible change of climate can be expected to accrue from an accession to the sun's mass approaching the earth in magnitude. "The only indication," he says, "which we can become cognizant of is the possible decrement in the length of the year."

Mr. Waterston proceeds to obtain and apply an approximate formula for determining the amount of this decrement. It results from this formula that a sudden increase of the sun's mass by a mass equal to our earth, occurring at the time of observation (September), would have resulted in a decrease of the major axis of the earth's orbit by 261 miles; and the length of the year would accordingly be diminished by 130 s., corresponding to an acceleration of the sun's mean (apparent) motion by 5″·3 in a year. Had the increase of the sun's mass occurred in July, the major axis would have been diminished by 255 miles, while the decrement would have been no less than 281 miles had the increase of mass occurred in December. In all cases the line of apsides would progress.

It may be remarked that the question of the effect of an increment in the mass of an attracting body has a bearing on a subject that has lately attracted much attention—the acceleration of the moon's mean motion. For it has been calculated by Reichenbach, that, on an average, at least twelve meteoric bodies fall daily upon the earth's surface, so that in 1,000 years upwards of four millions of these bodies must have been added to the earth's mass. Such an increment is almost infinitesimally small, no doubt, compared with the earth's mass, but, so far as it goes, it is an *effective cause* (i) of acceleration of the moon's mean motion, and (ii) of retardation of the earth's rotation.

* 'Monthly Notices,' vol. xx., p. 89.

The extraordinary variable star, lately discovered near ε Coronæ, appears to be identified with No. 2,765 of Argelander's Zone $+26°$, marked by Argelander as of 9·5 magnitude. Mr. Graham remarks that in Wollaston's catalogue (1790), an object whose place reduced to 1866 also accords with that of the variable, is noted as follows:—"Double (Hers. v. 75) v. v. uneq.... dist. 41″... pos^n 16° *s. f.*; really quadruple." Also that a nebula is marked on Cary's globe as nearly as possible on the spot occupied by the new star, and that this nebula is not in Herschel's catalogue. Sir John Herschel, on the 9th of June, 1842, marked as visible to the naked eye a star whose place agrees so nearly with that assigned to this star, that "he cannot help believing it to be the same." "If not a new star," he adds, "it is a variable star which merits attention for its own sake."

On May 19th (when the star had diminished to below the 5th magnitude) the Astronomer Royal's spectrum-apparatus was mounted on the great equatorial, and the spectrum of the star was observed at intervals by Messrs. Stone and Carpenter till June 7th, on which day the line near F was "visible but desperately faint." Their observations confirm the results obtained by Mr. Huggins, and described by him in our last Number.

Mr. Browning points out the advantages to be gained by substituting a reflecting prism for the diagonal mirror in a "silvered-glass" Newtonian. The prism reflects more light and with less false-colouring, for it is found that if a prism and a flat mirror placed side by side be made to reflect light from a common source, the circle from the prism is white, while that from the flat is strongly tinted with a reddish-chocolate colour.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

America.—Discovery of a new locality for *Scolopendrium officinarum.*—This fern was first found in America by Pursh, who gives as a habitat in his Flora, 1814, "shady woods among loose rocks in the western parts of New York, near Onondago, in the plantation of J. Geddis, Esq.;" Nuttall in his Genera, 1818, records it as "growing in the western part of the State of New York, in the crevices of calcareous rocks beneath *Abies Canadensis* and *Taxus Canadensis*;" and Dr. Asa Gray, in the Botany of the Northern United States, mentions as a station, "limestone rocks, in a deep ravine at Chittenango Creek, below the Falls, where it abounds." In May last, a new locality, where the Scolopendrium grows abundantly, was discovered in the United States by Lewis Foote, Esq., of Detroit, in the township of De Witt, about five miles from Syracuse and within a few miles from Onondago. A dried specimen was immediately sent to Dr. Asa Gray by the fortunate discoverer.

Messrs. Sullivant and Lesquereux, well known as the ablest Cryptogamic Botanists in the United States, have issued a second and greatly enlarged edition of their 'Musci Boreali Americani, sive Specimina Exsiccata Muscorum in Americæ Republicis Fœderatis detectorum' (the mosses of North America, or dried specimens of mosses detected in the Federal Republic of America). This edition is not a mere reproduction of the first, for whilst that contained a little over 400 species or marked varieties, this contains 536. The novelties in the second edition are partly from California, and contributed mainly by the zealous Bolander, also from the Rocky Mountains by Mr. E. Hall, and there are many new eastern species which have been detected by Messrs. James, Peck, Austin, Clinton, and Ingraham, as well as by Lesquereux himself. The price of the set is thirty-five dollars, or 7*l.* Each copy is accompanied by an octavo pamphlet of 96 pages, being a representation, in convenient printed form, of all the tickets characteristic of the new species, and an index. Applicants will address, M. Leo Lesquereux, Columbus, Ohio.

In a letter, dated March 26, 1866, which is published in the May number of 'Silliman's American Journal of Science and Art,' Professor Brewer gives some interesting facts as to the occurrence of living plants in the hot and saline waters of California. He says:—"The so-called Geysers in Pluton Creek, a branch of the Russian river, lying at an altitude of 1,700 feet above the sea, consist of numerous steam vents and hot springs of various temperatures, the hottest observed being 97° Centigrade, or about 207° Fahr. In these warm mineral waters low forms of vegetation occur, consisting of unicellular plants and filamentous Confervæ of a bright green colour. They were most abundant in waters of the temperature of 52° to 60° Centigrade, or 125° to 140° Fahr. The highest temperature noted in which the plants were growing was 93° Centigrade, or about 200° Fahr. The plants were unicellular in the hottest springs, and filamentous in springs of a lower temperature. These observations were made in November, 1861, and the facts were communicated, the following winter, to the California Academy of Natural Sciences." As a remarkable example of tenacity of life amongst the higher plants, *Lewisia redivia* is mentioned, a Portulacaceous plant, large flowered and fleshy, growing in British Columbia, Oregon, and California. Specimens of this plant will grow, although they have been dried and in the herbarium for two or three years, and indeed the samples are often troublesome from sprouting whilst between the papers. One species collected by Dr. Lyall, of the British navy, was "immersed in boiling water" to stop this growing propensity before submitting to the drying process, and yet more than a year and a half afterwards it showed symptoms of vitality, and in May, 1863, it produced its beautiful flowers in the Royal Gardens at Kew. This plant is figured in 'Curtis's Botanical Magazine' for August, 1863.

Belgium.—*The Cryptogamic Origin of Intermittent or Marsh Fevers.*—The writings of Dr. Salisbury on this subject have induced Dr. Hannon, Professor of Botany in the University of Brussels, to send to the 'Journal de Médecine de Bruxelles, Avril, 1866,' a very interesting letter on the same topic, from which it appears that Dr. Hannon entertains precisely the same views as Dr. Salisbury, on the influence which the spores of the algæ which grow in the marshes exercise in the genesis of these fevers, but he assures us that the facts contended for by the distinguished English physician have been long known in Belgium. "In 1843," says Dr. H., "I studied at the University of Liege. Professor Charles Morren had created in me such an amount of enthusiasm in the study of the physiology of the fresh-water algæ, that the windows and mantelpiece of my chamber were encumbered with plates filled with *Vaucheria*, *Oscillatoria* and Confervæ. My preceptor conversed with pleasure on my observations on these algæ, and each time he said to me, 'Take care, at the period of their fructification the spores of the algæ give intermittent fever. I have had it every time that I have studed them too closely.' As I cultivated my algæ in pure water and not in the water of the marsh where I had gathered them, I did not attach any importance to his remark. I suffered for my carelessness. A month later, at the period of their fructification, I was taken with a shivering; my teeth chattered; I had the fever, which lasted six weeks. I removed from Liege to Brussels and recovered under the treatment of Dr. Alphonse Leclercq. I related to Professor Morren what had happened to me. 'You see,' said he, 'that I was right; and you are not the only one that I have known become fevered through a similar cause.'"

Austria.—Professor Unger has communicated to the Imperial Academy of Sciences at Vienna, a paper on the vegetable and animal remains and relics of manufacturing art, contained in a brick taken from one of the Egyptian pyramids. He examined a brick from the pyramid of Dashour, which dates back from between 3400 and 3300 B.C., and found imbedded in the Nile mud or slime of which it is composed, animal and vegetable remains so perfectly preserved that he had no difficulty whatever in identifying them. Besides two sorts of grain he found the following familiar plants, *Pisum arvense*, *Linum usitatissimum*, *Raphanus raphanistrum*, *Chrysanthemum segetum*, *Euphorbia helioscopia*, *Chenopo-*

dium murale, Bupleurum aristatum, and *Vicia sativa.* The brick contained chopped straw, thus confirming the account of the brick-making given in Exodus. The manufacturing relics consisted of fragments of burnt tile, pottery, and a small piece of twine spun from flax and sheep's wool, significant of the advance which civilization had made more than 5,000 years ago. Professor Unger thinks that by a careful examination of a large number of bricks, much light may be thrown on the civilization of ancient Egypt. The bricks also contained abundant remains of fresh-water shells, insects, fishes, &c.

England.—*Discovery of a new British Lemnaceous Plant, the Wolffia arrhiza* (Wimmer).—Mr. Henry Trimen, M.B., F.L.S., has given a description of this plant in the August number of the 'Journal of Botany.' It is the smallest of our Phanerogams, and was found by Mr. Trimen in a pond near Staines, Middlesex, where it grows in abundance, floating on the surface of the water between the fronds of *Lemna polyrrhiza, L. gibba*, and *L. minor.* This minute plant has a very extensive geographical range, being found in Portugal, France, Italy, Switzerland, Germany, Bengal, Eastern Java, Angola, Egypt, and New Orleans. This species has since been detected in the Kew herbarium, dried, amongst samples of *Lemna minor*, and not named. Since the above discovery was made, a new station of this plant has been found by Mr. M. Moggridge, in a pool near St. James's Church, Walthamstow, Essex. As the *Wolffia arrhiza* is smaller than a pin's head, and occurs in company with other duck-weeds, it is probable that it exists in many other localities, and might be found if such places were carefully examined. Dr. Gray, of the British Museum, thinks that this plant is not a recent importation to England, as about 50 years ago Mr. Bennett and himself had some specimens of it brought to them by M. Gerard, which were found on Putney Common. M. Gerard maintained that it was *Lemna arrhiza*, but Dr. Gray thought at the time that "it was only a young state of *Lemna minor*, for the difference between the fructification of the two plants had not been then described."*

The Lemnaceæ of British India have also been described by Mr. Sulpiz Kurze, Curator of the Herbarium of the Royal Botanical Gardens, Calcutta. Seven species are enumerated, two of which are new, and, so far as at present is known, restricted to India, *viz. Wolffia microscopica*, Kurz., and *Lemna oligorrhiza*, Kurz. Duck-weeds, therefore, occur nearly as generally in the tropics as in northern countries, though a moist region, covered with tanks and rivers, is more favourable to them than a dry one. Bengal is rich, not only in species, but in the number of individuals. As to the

* See 'Journal of Botany,' August, 1866.

vertical distribution of these small water-plants in India, the individuals and species decrease in number as we ascend the mountains. At Java, 5,000 feet above the sea, where lakes and pools abound, scarcely any duck-weeds exist. In Laboul, however, *Lemna minor*, the only species known in that district, ascends to 9,500 feet.*

The Herbarium of the British Museum.—From the official report of the Botanical department published recently, we learn that during the year 1865 the following additions have been made to the collection:—1,500 species of plants in the form of a herbarium; 269 species of plants from the Shetland Islands; 250 British fungi; 5 microscopic fungi; a monograph of British Cladoniæ, containing 80 species; 269 species of Swedish plants; 200 plants, forming cent. 34 and 35 of Billot's 'Flora Gallicæ;' 1,000 species from the Tyrol; 100 Italian species, being fasciculi 23 and 24 of the 'Erbario Crittogamico Italiano;' 400 of the rarer plants of Sicily; 76 roses; 273 European mosses; 100 fungi; 130 algæ; 30 microscopic slides of Diatomaceæ; 1,078 species of South African plants; 1,600 from the Zulu country; 2,850 from Venezuela; 2,127 from Cuba; 2,000 garden specimens from Mr. John Smith's Collection; and 100 fruits and seeds from Mexico: altogether, 13,027 species, the accumulations of a single year.

Mr. M. C. Cooke publishes a valuable paper on leaf Sphæriæ, in the 'Journal of Botany,' August, 1866, containing descriptions of 28 species, eleven of which are new to science, and therefore described by Mr. Cooke for the first time. Eight of these novelties were collected by Dr. Edward Capron, of Shere, Surrey, and the remaining three were gathered by Mr. Cooke. All interested in the study of microscopic fungi will give due credit to these gentlemen for thus contributing to our knowledge of leaf Sphæriæ. The following are the names and habitats of the new species:—

Venturia Myrtilli: on semi-putrid leaves of *Vaccinium Myrtillus. Venturia licifolia:* on semi-putrid leaves of Holly. *Sphærella oblivia:* on under-surface of dead Chesnut leaves. *Sphærella arcana:* on dead leaves of Castanea vesca. *Sphærella simulans:* on dead Oak leaves, Highgate, 1866. *Sphærella punctoidea:* on upper surface of Oak leaves. *Sphærella millegrana:* on upper surface of dead leaves of Hornbeam. *Sphærella latebrosa:* on dead leaves of Sycamore. *Sphærella Acerifera:* on dead leaves of *Acer campestris. Sphærella inequalis:* on dead leaves of *Pyrus aria. Sphærella Vaccinii:* on semi-putrid leaves of *Vaccinium Myrtillus.*

France.—*New Paper from Vegetable Matter.*—M. Cannisade has taken a patent in France for the manufacture of paper from the

* See 'Journal of the Linnean Society,' vol. ix., No. 37.

roots of the Lucerne. When these roots are dried and crushed they leave visible thousands of very white fibres, which form an excellent pulp for the manufacture of paper, and a good substitute for rags. The species of Lucerne employed for this purpose are *Medicago media*, *M. falcata*, and *M. maculata*.*

A paper, entitled "Investigations as to the Rottenness of Fruits and other parts of Living Vegetables," by M. C. Davaine, has been communicated by M. Ch. Robin, to the French Academy, and appears in 'Comptes Rendus,' No. 8, August 20, 1866. The experiments of M. C. Davaine recorded in this paper prove that the rottenness of fruits is the result of the attacks of fungi, the different varieties in the form of the decay being produced by generic differences in the attacking fungi by the spores of which the fruit has been inoculated. Thus the rottenness determined by a *Mucor* or a *Penicillium* differs in density and colour as well as in rapidity of development; and all the other Mucedineæ produce a rottenness so characteristic, that the name of the fungus which produced the mischief may be at once determined; for example, a *Helminthosporium* which attacks the carrot, produces a black putridity; a *Selenosporium?* Corda, which M. Davaine observed upon the cucumber, and which he propagated on this fruit, gives a beautiful red colour to the flesh of the cucumber, whilst the rottenness of the same fruit resulting from the invasion of a *Mucor* or a *Penicillium* has no particular coloration. M. Davaine deduces the following conclusions from his experiments: —1. The common Mucedineæ which develope on inert substances are able also to be generated on living organisms, and it is not necessary that the organism should be altered by disease in order to form a suitable nidus for the development of the spores; it is sufficient that the tissues be inoculated with them even when in a state of health. 2. The consequences resulting from the development of these fungi is a profound alteration of the tissues or structure of the part of the plant invaded, designated commonly by the term rottenness. 3. This rottenness varies with the character of the Mucedineæ by which it is determined; the most usual conditions under which rottenness developes being atmospheric humidity.

IV. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

M. Stas, of Brussels, has for many years been engaged upon experiments to determine the atomic weights of a few simple bodies.

* See 'Journal de Chemie Médicale de Pharmacie de Toxicologie,' par M. A. Chevallier, August, 1866.

They have been carried out on such a scale and with such precautions as are without example in chemical investigations. The primary object of M. Stas was to ascertain the truth or falsehood of Prout's theory, that the atomic weights of all simple bodies are multiples of that of hydrogen; the result has been to convince the author that the theory is without foundation in fact. We append a few of the author's determinations, reserving a fuller notice of his experiments for a future occasion. Taking then hydrogen as the unit, the atomic weight of oxygen will be 15·960; of chlorine, 35·368; of iodine, 126·533; of potassium, 39·040; of sodium, 22·980; and of silver, 107·660.

Schönbein has published another contribution to the knowledge of Peroxide of Hydrogen. In this paper he gives an easy method of producing a weak solution of the body, which will probably answer to make the tests subsequently described. A small quantity of amalgamated zinc turnings and a little water are shaken for a few minutes in a flask or bottle containing either pure oxygen or atmospheric air. By this a little oxide of zinc is formed, and the water is found to contain a small amount of peroxide of hydrogen. The author states that a strip of white filter paper dipped in a solution containing only one-half per cent. of the peroxide, and then dried in the air at the ordinary temperature, will show all the reactions of the peroxide. When touched with a solution of acetate of lead it will turn brownish yellow, and when touched with a dilute solution of ferrous sulphate with iodide of potassium and starch, it will be instantly coloured the deepest blue. Schönbein further tells us that although peroxide of hydrogen is volatile, a solution may be concentrated by boiling and indeed almost dehydrated by evaporation over sulphuric acid and under an air-pump. As showing the condition of the oxygen in the peroxide, the author mentions that a strip of paper dipped in a solution of the latter, and then suspended in a bottle of ozonized air soon ceases to exhibit the reactions of the peroxide, while the end of the strip left outside the bottle continues to show them for hours.

The fact that oxygen combines with metals in different conditions receives further support from an experiment described by Dr. W. Schmid. This chemist has found that an excess of freshly precipitated peroxide of manganese placed in a solution of sulphate of copper causes the precipitation of the latter metal in the form of peroxide, the manganese passing into solution as sulphate.

In the list of elements in many works on chemistry the name of a supposed metal, Norium, is placed, said to have been discovered by Svauberg in 1845. The discoverer thought he had proved that zirconia was a mixture of two earths. Recent researches by R. Hermann have however shown that sufficient differences exist in zirconia of various origins, mainly depending on the presence of alumina, to account for the facts on which Svanberg based his fancied discovery. A variety of researches by R. Hermann on the rarer earths will be found in No. 6 of the 'Journal für praktische Chemie' for this year.

Dr. Rudolph Wagner has found that the rare metal Indium is to be met with in the flue dust of zinc ovens, where indeed it might naturally be looked for. The fact is worth mentioning, and we believe it would repay a chemist to examine the flue dust wherever blende is roasted.

The same author has also published a process for the extraction of mercury from poor cinnabars, partly in the moist way. He treats the ore with a hot solution of sulphide of barium, which dissolves the sulphide of mercury, to be precipitated again by the addition of hydrochloric acid. The sulphide so obtained can be reduced or used directly for the preparation of mercurial salts. Incidentally the author gives a process that can be applied to the valuation of the ore. Cinnabar he finds is in the course of a day or two completely decomposed by a solution of iodine in iodide of potassium, iodide of mercury being formed, and sulphur set free. The difference in the amount of free iodine, ascertained by means of hyposulphite of soda, will show how much has combined with mercury, and consequently how much mercury is present.

M. Roussin has suggested the use of the metal Magnesium in toxicological examinations. It rapidly and completely precipitates the poisonous metals without the risk of introducing another to complicate or falsify the results. It can also be used in a Marsh's apparatus in place of zinc with the utmost confidence, since it has been shown by Professor Wanklyn, as well as by M. Roussin, that commercial magnesium is perfectly pure.

We have in former numbers mentioned the new analyses of Harrogate waters, and may here add that further investigations by Dr. Muspratt and Mr. R. H. Davies have revealed the presence of lithia and strontia in all the springs. Mr. Davis has found as much as 3·242 grains of carbonate of strontia in a gallon of the water of the Old Sulphur Well, and 2·815 grains in the Kissingen spring. The amount of lithia has not been determined; but its presence has been recognized by means of the spectroscope. Continual changes seem to be taking place in the saline constituents of the Harrogate waters, barium salts, together with the strontia, and probably the lithia having appeared within the last few years. No one of these bodies was detected by Dr. Hofmann in 1854.

One of the most important papers on technical Chemistry published during the past quarter is the second part of the Memoir of M. Kolb "On the Manufacture of Soda by Leblanc's Process." As this is a most important branch of industry in this country, where upwards of a thousand tons of common salt are daily consumed in the manufacture, we may direct the reader's attention to the original memoir, which will be found in the 'Annales de Physique et de Chimie' for June, 1866, or to a full abstract in the 'Chemical News,' Nos. 345, 347, and 348. The most important point brought out by the elaborate researches of the author is the necessity for rapidly lixiviating the ash, and the great desideratum of the manufacture at present is a system of apparatus to accomplish this.

Mr. Walter Weldon has devised and patented a process intended to supersede Leblanc's; but we are not aware that its practicability on a large scale has yet been demonstrated. The chemistry of the process is very simple. The inventor places in a vessel capable of withstanding great pressure an equivalent of common salt and an equivalent of carbonate of magnesia together with a little water. Carbonic acid gas, obtained by the cheapest means, is then forced in, to convert the carbonate into bicarbonate of magnesia. The solution of this salt, it is said, decomposes the chloride of sodium, producing bicarbonate of soda, which is precipitated, and chloride of magnesium, which remains in solution. A very moderate temperature will, of course, reduce the bicarbonate to carbonate of soda. The solution of chloride of magnesium is evaporated to dryness and the residue ignited, whereby the chlorine is driven off and magnesia left for another operation.

A very important contribution to Physiological Chemistry has been made by M. Melsens. It is well known that chlorate of potassium and iodide of potassium do not react on each other when brought together under ordinary circumstances, and that either may be administered to an animal without producing any toxic effect. But when these two salts are administered together the author finds that iodate of potash is formed in the body and the animal is poisoned.

The various albumenoid bodies of both animal and vegetable origin have undergone a tolerably complete investigation by Dr. A. Commaille, of whose thesis a full abstract is published in the 'Journal de Pharmacie et de Chimie' for August. The author's researches, and indeed those of other chemists, on white of egg seem to prove that sulphur is not an essential constituent of the albumen, but is contained in a volatile principle perfectly distinct. However that may be, it is shown that the sulphur is set free when the albumen is coagulated by heat. Raw white of egg has no action on silver, which is blackened, and indeed corroded, by contact with the coagulated albumen.

In the gluten of wheat the author finds as many as five distinct nitrogenized principles, in the blood three, and in milk also three. "The land of protein bodies," it has been said, "is a land full of undefined shapes which only here and there present a well-marked form, and their investigation constitutes a series of problems among the most abstruse to be met with in the whole range of animal chemistry." Dr. Commaille's memoir is an important contribution to our knowledge of these ill-defined shapes.

On advanced Organic Chemistry, it is hardly necessary to say that a large number of papers have been published, but for these we must refer our readers to journals specially devoted to the science.

Among recent publications on Chemistry, we may direct attention to a very useful little manual by Dr. Roscoe, entitled 'Lessons in Elementary Chemistry.'* It forms an admirable introduction to the study of the science on modern principles.

Proceedings of the Chemical Society.

On June 7, Professor Wanklyn read a paper "On the Oxidation-products of the Propione produced from Carbonic Oxide and Sodium Ethyl;" Mr. E. T. Chapman gave an account of "Some Decompositions of Nitrite of Amyl;" and Mr. Bassett described "A Cyanogen Derivative of Marsh Gas." Abstracts were also read of papers by Drs. Stenhouse and Müller "On the Preparation of Chrysammic Acid and Chrysammic Ether;" by Professor Kolbe and G. Wirchen, entitled "A Preliminary Notice of Phthalic Aldehyde;" and the title of a paper by the late Mr. E. A. Hadow was read. This paper, which gives the results of some of the latest work of its skilful and conscientious author, is on the Platinum bases; the best mode of obtaining and identifying them.

At the same meeting Mr. A. Vernon Harcourt delivered a lecture "On the Course of Chemical Change."

On June 21, Dr. F. C. Calvert gave an account of some experiments made by himself and Mr. Johnson "On the Action of Acids upon Metals and Alloys."

These experiments possess great scientific as well as practical value, since they have led the authors to the following established conclusions: 1. That the extent of action of any acid upon an alloy cannot always be predicted from the known effects of the same acid upon individual metals. 2. That a variation in the proportion of the constituent metals, no greater even than 10 per cent., will sometimes entirely change the character of an alloy, so far as regards its corrosion by and solubility in acids. 3. That the influence of water in modifying the action of acids on metals and alloys is, in nearly all cases, very considerable. Among the most interesting of the results were those obtained by the action of sulphuric acid of various strengths on pure zinc. With monohy-

* Macmillan & Co., 1866.

drated acid there was no action in the cold, but on heating to 150° C. the metal dissolved, and sulphurous acid was disengaged. With tetra- and penta- hydrated sulphuric acid, much sulphuretted hydrogen was evolved, and only traces of sulphurous acid. With acids containing seven atoms of water and upwards, only hydrogen was given off. We must refer our readers to the 'Journal of the Chemical Society' for the complete results of these valuable and interesting experiments.

At the same meeting Dr. Debus gave a short discourse "On the Constitution of some Carbon Compounds."

An extraordinary meeting of the Society was held on July 5 to dispose of the remaining papers, and to hear a discourse by Professor Williamson "On the Constitution and Representation of Organic Compounds." The best idea of the author's system will be given by quoting a few of his formulæ: Alcohol, $H_3 \vdots\ C.\ \overset{H_2}{C}.\ \ddot{O}.\ H.$; oxalic acid, $H.\ O.\ \overset{O.}{\ddot{C}}.\ \overset{O.}{\ddot{C}}.\ O.\ H.$ Professor Williamson claimed for his system the merit of greater simplicity than those of Kekulé and Crum Brown; but the length to which the formulæ of some bodies written upon the system must extend, will be a great objection to its adoption.

Mr. W. Thorp afterwards read a paper "On the Reduction of Oxides of Nitrogen by Metallic Copper in Organic Analysis," in which the author showed that in determining nitrogen by volume, as in Dumas' method, it is essential to maintain the heat at bright redness, and to pass the gas very slowly over the copper.

A note "On the Hydrocarbons contained in Crude Benzol," by Mr. C. Schorlemmer, was also read. We referred in our last to the discovery by the author of a new series of hydrocarbons in coal-tar. The author has, in fact, obtained by the treatment of crude benzol with bromine a body having the composition $C_6\ H_{10}\ Br_4$, from which he infers that besides the members of the olefine series crude benzol contains the hydrocarbon $C_6\ H_{10}$, identical, he believes, with the hexoylene of M. Caventou.

It is worth mentioning here, that to prepare perfectly pure benzol, Mr. Schorlemmer recommends treatment of the crude mixture of hydrocarbons with bromine, and subsequently with potash before rectification. In this way a product is obtained which gives a nearly colourless nitro-benzol, and dissolves in concentrated sulphuric acid without much coloration.

V. ENTOMOLOGY.

(Including the Proceedings of the Entomological Society.)

The old opinion as to the hermaphroditism of the viviparous Aphides has been revived by M. Balbiani. According to his statement in the 'Comptes Rendus,' the main facts seem to be that the vitelline vesicle separates into two cells, and that each of these cells subsequently becomes covered on its surface by a generation of small cells which gradually increase in size and number. From these two cellular groups, placed side by side in the cavity of the blastoderm, originate the male and female elements of the future animal—that is to say, of the ova in the one and the spermatic fecundating corpuscules in the other. The formation of the spermatic bodies commences very early, for all the embryos of the viviparous aphides at the moment of their birth contain new generations in the course of development. The observations which M. Balbiani has made indicate, he thinks, that the egg, while in the ovary, undergoes a first fecundation with which the male has nothing to do, and the effect of which is limited to the generation of the elements of the future animal. In the oviparous aphides the formation of the embryo does not commence until after the fecundation by the male and the deposition of the egg which succeeds.

In the 'Annales de Sciences Naturelles, Zoologie' (July, 1866), M. Meinert calls attention to two articles published by him in the 'Naturhistorik Tidsskrift,' the one sustaining the opinion of the origin of the Cecidomya larvæ in the adipose tissue against the opinion of M. Pagenstecher (ante, p. 269); and the second asserting that the statements of various observers have been drawn from two different forms belonging to very different genera —the *Miastor metraloas* (the one on which Professor Wagner's discovery rested), and a hitherto undescribed species which he has characterized under the name of *Oligarces paradoxus;* in neither is there formed an ovary properly so called, as M. Leuckart has asserted. The egg he considers to consist of a single cell, "la cellule germinative."

Dr. Packard has communicated to the 'Annals and Magazine of Natural History' (August, 1866), a paper recently read before the Boston (U.S.) Natural History Society, entitled "Observations on the Development and Position of the Hymenoptera, with Notes on the Morphology of Insects." The "observations" were chiefly made on the genus Bombus, and its successive stages are minutely described. The author considers that twenty rings, or somites—for which he proposes a new name (*arthromere*)—as a rule, compose the body of insects, of which seven are contained in the head, three in the thorax, and ten in the abdomen. We may observe, however, that Professor Huxley, taking the moveable appendages as the test of the number of rings, came to the conclusion that "never more than six, and never fewer than four, somites enter into the composition of the head" in the Arthropoda generally, while in insects he limits them to five. In a masterly article, however, in a former volume of the same series,* from which we have just quoted, the late Dr. Schaum throws considerable doubt on the hypothesis of a separate cephalic segmentation. We have not space here to enter into his arguments, which we believe have not hitherto been answered. Perhaps one of the strongest is that there is never more than one ganglion in the head, while in the larvæ with homonomous segments the ganglia correspond to the segments.

The Mountain Silk of North China is likely to become an article of commerce. Mr. Consul Meadows reports that there are two crops in the year—a spring crop of greatly superior quality, and an autumn crop much more abundant than the former. The autumn cocoons intended for the spring crop are exposed nearly all the winter to a temperature considerably below the freezing point, notwithstanding which the moth comes forth in the first warm days of spring; eggs are produced in four or five days, and in a few days more the caterpillars are hatched. These are soon transferred to the oaks on the hill-sides, and when they have acquired their full size they commence forming their cocoons. The chrysalids which are not kept for breeding are used by the Chinese as an article of food.

A new work, entitled 'Rhopalocera Africæ Australis,' has just been received in London. It is an account of the butterflies of the Cape Colony, by Mr. Roland Trimen, an accomplished entomologist, well known for the years of study which he has bestowed on the African diurnal Lepidoptera. Although a colonial publication, it is quite equal in its "getting up" to the average of English works of the same class.

Entomological Society.

June.—Professor Brayley communicated an extract from the report of Mr. Consul Zohrab, respecting the occurrence of a venomous spider in the corn-fields of Berdiansk, from the bite of which many persons had suffered severely. Mr. Pascoe exhibited a small collection of Coleoptera from Western Australia, made by the Rev. George Bostock, of Freemantle. They were found principally in ants' nests. Among them was a remarkably isolated

* Vol. xi., p. 173 (1863).

genus of an entirely new type of form, having, however, from its three-jointed antennæ a certain analogy with the Paussidæ. It was described under the name of *Ectrephes formicarum*. Descriptions of other curious species were also laid before the meeting. Mr. Stainton made some observations on the difficulties of determining the species of *Gelechia* feeding on the Caryophyllaceæ. Professor Westwood exhibited drawings and read descriptions of various species of *Goliathi* from the Zambesi. Mr. Wilson, of Adelaide, communicated further Notes on the Buprestidæ of South Australia.

July.—Among the exhibitions were a collection of Lepidoptera from Mexico, by Mr. E. Saunders; of examples of *Dicranocephalus Wallichii*, from Northern India, and of *D. Bowringii*, from Southern China, by Mr. Stevens. Mr. Bond also exhibited a specimen *Dianthœcia cæsia* recently taken in the Isle of Man. Mr. Pascoe called the attention of the meeting to a paper by Mr. A. Müller, in the 'Zoologist,' respecting the cylindrical holes formed by insects alighting on the snow in the Higher Alps, and confirming the observations made by him (Mr. Pascoe) at a former meeting. Von Tschudi, in his 'Thierleben der Alpenwelt,' has stated that some of these holes attain a depth of two feet, and that the insects alighting on the snow do so apparently for the purpose of enjoying the oxygen which is *supposed* to be set free during the thawing of the snow. The Rev. Douglas Timmins communicated some notes on the larvæ of *Charaxes Jasius* and *Melitæa provincialis*.

August.—Collections of insects of all orders were exhibited by Mr. Stevens, from Madagascar, formed by Mr. Gerrard; and from Bahia, formed by Mr. Read. A collection of the cases of Caddis-flies from various parts of Europe were exhibited by Mr. McLachlan. Mr. Janson exhibited a pair of the rare *Velleius dilatatus*, found in the nests of the Goat-moth in the New Forest. Professor Westwood read an account of the ravages recently committed by locusts in Algeria, apparently one of the most destructive visits of those insects ever recorded.

VI. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

The most important geological event of the past quarter is, no doubt, the publication of the third volume of the 'Memoirs of the Geological Survey of Great Britain,' consisting entirely of Professor Ramsay's long-promised work on 'The Geology of North Wales.' The descriptions of the fossils have been drawn up by Mr. Salter, and their illustration by Mr. Bone leaves nothing to be desired on that score.

It is difficult to give in a short notice an adequate idea of the contents of such a work; it must therefore suffice to say that it consists chiefly of a detailed description of the Silurian rocks of North Wales, given in such a manner "that any one may ascertain the structure of any minor area in which he may be interested." We shall therefore endeavour to cull only a few opinions and statements of the author, which may be of general interest.

Of all subjects, perhaps that of breaks and unconformity is the one which Professor Ramsay has most successfully treated, not only in this work, but elsewhere. As regards the Lower Silurian rocks, there is no sign of unconformity between the Cambrian and the overlying Lingula-flags. The Tremadoc slates, which are extremely local in their occurrence, and the fossils of which have an aspect of their own, though more like those of the Lingula-flags than of the overlying strata, are probably unconformable on the former. The Llandeilo-flags succeed the Tremadoc slates, and there seems good reason to suspect an unconformity here also; but between the Llandeilo-flags and the beds above (Bala or Caradoc) there is no sign of unconformity; nor has any been proved to exist between the Caradoc strata and the Lower Llandovery above. Here the Lower Silurian series ends.

The Upper Silurian begins with the Upper Llandovery beds, which are found reposing indifferently and unconformably on any of the Lower Silurian deposits. This line of division, therefore, seems coincident with a natural break; indeed, Professor Ramsay states that before the Upper Llandovery beds were formed, all the lower members of the Silurian series had been disturbed and planed across by denudation. The Tarannon Shale, which comes next, is sometimes conformable to the Upper Llandovery, but sometimes overlaps it, and reposes unconformably on older strata; but the Wenlock and Ludlow beds above are in conformable succession to it.

Professor Ramsay's opinion of the signification of these later unconformities is thus given:—"The strata that lie between the top of the Caradoc, or Bala beds, and the base of the Wenlock Shale, were formed during a period of frequent oscillation of the relative level of the land to the sea. This oscillation succeeded the long and continuous deposition of the Bala beds, and preceded the formation of the Wenlock and Ludlow strata. The Lower and Upper Llandovery beds and the Tarannon shale belong, in fact, to a middle portion of the Silurian epoch only. Three fragments of this episode have alone been preserved, and while the oldest, that of the Lower Llandovery beds, is somewhat closely connected with the Lower Silurian period, the remaining two are more nearly related to the Upper Silurian age."

The object of the memoir is to elucidate these phenomena as far as they apply to North Wales, and as such it is a very welcome and useful addition to our knowledge of British Geology.

The literature of *Eozoon* continues to increase with great rapidity, and in this Chronicle we shall have to notice three important contributions thereto. The first of these is 'On the Occurrence of *Eozoon* in the Primary Rocks (Urgebirge) of Eastern Bavaria,'* by Dr. Gümbel, and its importance consists, not so much in its being the record of the occurrence of *Eozoon* in the Laurentian gneiss of Bavaria, as in its containing the description of a new form of that fossil (to use a negative term), which is considered by the author to constitute a new species, and for which he proposes the name *Eozoon Bavaricum.* This new species occurs at a much higher horizon than the original *Eozoon Canadense,* as will be seen by the following table of the Bavarian deposits, given in descending order :—

1. Hercynian Clay-slate with *Eozoon Bavaricum* .	Cambrian ? or Huronian ?
2. Hercynian Mica-schist	Upper Laurentian.
3. Hercynian gneiss, with *Eozoon Canadense* . .	Lower Laurentian.
3. Bojic gneiss	Lower Laurentian.

Now, if the characters of *Eozoon Bavaricum* are really constant, and of specific value, the fact of there being known two recognizably distinct species of the genus adds enormously to the chances of both forms being of organic origin, the more so as the structural differences are associated with an immense difference in age. Moreover, Dr. Carpenter, in a postscript to a paper which we shall presently notice under the head of "Proceedings of the Geological Society," has recognized the similarity of the characteristic structures of the Bavarian *Eozoon* to those of the Eozoon of Connemara, which occurs in a still newer rock, namely, Lower Silurian. We may therefore quote an editorial note appended to an abstract of Dr. Gümbel's paper in the 'Quarterly Journal of the Geological Society,'† which is as follows :—"This observation is of considerable interest when viewed in connection with the relative geological age of certain Eozoonal rocks, more especially the probable Cambrian date of *Eozoon Bavaricum,* the Lower Silurian position of the Connemara serpentine, and the Laurentian age of *Eozoon Canadense.*" At the same time it does not appear that Dr. Carpenter has expressed any opinion as to the specific distinctness of *Eozoon Bavaricum* from *Eozoon Canadense.*

The characters which are more especially relied on as distinctive are (1) the much smaller size of the individual structures in the

* Sitzungsberichte der Königl. Akad. der Wissenschaften in München. 1866. I. Heft 1.

† No. 87. Part 2 ; Miscellaneous, p. 24.

new species, and (2) the greater development of the irregular or "acervuline" portion.

In discussions as to the organic origin of *Eozoon*, it is, of course, desirable to bring forward as much collateral evidence as possible. Dr. Gümbel therefore cites several facts which he interprets to be indications of other organisms, the contemporaries of *Eozoon*. Especial stress is laid on the occurrence of graphite in the Hercynian gneiss of Bavaria and the Danube, and of beds of limestone in various localities; these the author believes to be the result of organic agencies, and although many geologists may agree with the conclusion, there are not a few, especially among mineralogists, who will decline to accept it. Dr. Gümbel, however, figures some tubular and reticulated bodies which certainly have a very organic appearance, but must be extremely minute.

The occurrence of *Eozoon* in Ophicalcite (serpentinous limestone) now appears to be very general, although the determinations do not always rest on very sufficient data; but it seems remarkable that this is the only kind of rock which is yet known to have yielded it; and those who disbelieve in the organic origin of the fossil have not failed to use this as a powerful argument in support of their views.

For many years the great "Diluvial" plain of Northern Germany has been literally harried by Prussian geologists in searching for fossils which might assist in solving the problem of the mode of its formation. Until the last two years, however, only fresh-water fossils had been found, in the region between the Elbe and the Oder, and particularly in the Potsdam district. Consequently, although it was difficult to believe that this great plain was of other than marine origin, yet the absence of marine fossils over the whole area was a fact of so much importance that a contrary conclusion seemed almost inevitable. In 1864, Dr. Ferd. Roemer recorded the discovery of *Cardium edule* and *Buccinum reticulatum* in the "Diluvial" deposits of the neighbourhood of Bromberg,* and justly considered it of great importance as being the "commencement of the discovery of the *hitherto quite unknown* marine fauna of the North German Diluvium." In the last number of the same 'Zeitschrift'† there is an account by Herr G. Berendt of the occurrence of these and three other species in West Prussia. The additional species are *Tellina solidula*, Lam., *Cerithium lima*, Brug. (*C. reticulatum*, Lov.), and a *Venus* which always occurs in fragments, but which appears to correspond with *V. pullastra*, Mont. The *Cardium* and the *Tellina* live now in the Baltic; the *Buccinum* has not been observed nearer than Kiel, but abounds on the shores of the North Sea, to which belong exclusively the *Venus*

* 'Zeitschr. der deutschen geol. Gesellschaft,' vol. xvi., p. 611.
† Vol. xviii. Heft. 1. p. 174.

and the *Cerithium*, which, however, are the most rare in the Diluvial deposits. All the species have thicker shells than their recent relatives, indicating, Mr. Berendt thinks, a salter sea than the Baltic of the present day. These facts are not very numerous absolutely, but relatively they form an immense addition to our knowledge of the fauna of the North German Diluvial Ocean.

M. Dupont has published, in the 'Bulletins of the Royal Academy of Sciences of Belgium,' the results of his explorations of the Caves* and Quaternary deposits† of the valleys of the Lesse and the Meuse. Along the course of the Lesse he discovered fourteen caves, of which we may take that of Chaleux as the type, and as being of most interest. This cave is shown to have been inhabited by man during three successive periods; and its exploration has yielded more than 30,000 worked flints, with numerous bones of Reindeer, Goat, Ox, Horse, Boar, Brown Bear, Fox, Badger, Polecat, Hare, and Water-rat. Most of these animals are supposed to have served as food for man, *especially the Horse.* Many human bones have also been discovered, and the condition of some of them has led to the inference that the ancient inhabitants of the caves were cannibals. The cave of Furfooz is supposed to have been used as a cemetery during a period anterior to the deposition of the Loess; and bones of the Brown Bear, Reindeer, Chamois, Beaver, Horse, &c., many of them fractured and burnt, are thought to represent the remains of a feast. The Quaternary beds also belong to three periods, namely, the upper stage with *Cervus tarandus;* the middle stage with *Ursus spelæus;* and the lower stage with *Elephas primigenius.* Rough-worked flints were found below the Loess, and polished ones above it,—a fact which confirms the observations of M. Malaise at Spiennes.

The 'Geological Magazine' for the quarter has been well filled with interesting matter, chiefly in relation to Denudation. We may especially draw attention to Mr. G. P. Scrope's articles in the June and July numbers, "On the Origin of Hills and Valleys," and "On the Terraces of the Chalk Downs." The object of the first paper is to counteract the tendency which the author fears exists in the minds of certain geologists, to ignore the action of subterranean force in helping to produce the present "form of the ground." Professor Jukes, he thinks, falls into this error when he speaks of "the action of internal forces" as "having no direct effect on the external features of the ground," except in the case of volcanic cones and craters. It was easy to see that Professor Jukes would reply that he fully acknowledged the *indirect* effect of subterranean forces, but that other causes had so modified the features which they had produced, that on the true "form of the ground" they had left little or no trace. The difference in opinion between these two

* Vol. xx., 1865, p. 824. † Vol. xxi., 1866, p. 366.

eminent men seems to be merely the difference in the meaning which they habitually attach to the expression "form of the ground." Mr. Geikie's paper "On Traces of Permian Volcanoes in Scotland" will be read with interest by those who remember his article in the last number of this Journal, and students of fossil botany will be pleased with the admirable paper "On Araucarian Cones" by Mr. Carruthers.

The July number opens with a description of an ancient coast-line in North Wales from the pen of a lady-geologist—Miss Eyton. It also contain's Mr. Scrope's second paper, in which he shows that Mr. Mackintosh had mistaken the terraces (called linchets or balks) worn out of the chalk and oolite hill-sides for sea-beaches! Mr. Scrope says of this notion, "I venture to say that a more preposterous idea has seldom been started for the confusion of geologists." But we think it will confuse very few, especially after Mr. Scrope's able description of the manner in which the linchets really are formed; and the test of their composition, which everyone may apply for himself. If they were sea-beaches they would be composed of sand and shingle; but in reality they consist of "wash" from the beds above. The other articles in this number are "On some Sarsens found in the Gravel near Southampton," by Lieut.-Col. W. T. Nicholls; "On some Polyzoa from the London Clay at Highgate," by Mr. G. Busk; and "On the Rock of the Cambridge Greensand," by Mr. Harry Seeley. Those interested in the "Denudation" question will find Mr. Jukes's letter, to which we have already referred, well worthy of a careful perusal.

The August number contains the first portion of a translation of Dr. Lindström's important memoir on operculated corals; but we shall reserve our remarks upon it until after the whole has been published, merely observing that the editor has conferred a real boon on palæontologists ignorant of Swedish. In a paper "On the Structure of Valleys in Essex," Mr. Searles Wood, jun., endeavours to prove that the valleys of the Blackwater and the Crouch have been formed by flexures produced from lateral pressure exerted from a centre or focus of earthquake disturbance under the Boulder-clay sea, "which flexures, by imparting direction to the denudation, had become deepened and strongly marked by the action of denudation proportionately to the extent to which they had undergone that process." The succeeding changes were of a somewhat complicated character, which it is necessary to read the paper to understand. In a short note "On the Disintegration of a Chalk Cliff," the Rev. Osmond Fisher most ingeniously shows that the profile of the solid chalk behind the talus formed by the disintegration of the upper portion of the cliff would be that of a semi-parabola, whose vertex is at the base of the original cliff. This number of the Magazine also contains two other papers on

Denudation, which are useful contributions as records of facts; their titles are: (1) "Ancient Sea-margins in the Counties Clare and Galway," by Mr. G. H. Kinahan; and (2) "On Watersheds," by Mr. G. Maw.

The 'Athenæum' records the discovery, by the Rev. W. Fox, of a Wealden Dinosaur of a new type, "its backbone being hollow, smooth, and compact, like a reed." It has been named *Calamospondylus Oweni* by its discoverer.

Proceedings of the Geological Society.

The very suggestive number of the 'Quarterly Journal' which we have this quarter to notice contains so many papers, on such a variety of subjects, that we must group those on kindred matters of general interest, and unwillingly pass over the rest.

The first two papers relate to *Eozoon*, so they may be naturally discussed together. The first of them, by Messrs. King and Rowney, is an endeavour to prove that the "Eozoonal" structures are the result of inorganic agencies; and the second, by Dr. Carpenter, is a supplement to his former papers on the Structure of Eozoon (in the same and other journals), viewed as an organic fossil.

In noticing the papers by Sir Wm. Logan, Drs. Dawson, Carpenter, and Sterry Hunt,* we made our readers acquainted with the chief features in the structures characteristic of *Eozoon*; we shall therefore consider them already understood, in a general way. Of these structures Dr. Carpenter relies chiefly upon the "asbestiform layer" or "proper wall" of the chambers, as especially demonstrating the organic nature of the fossil. According to him this is a calcareous band nearly surrounding the chambers, and perforated, during the life of the animal, by numberless tubules forming the passages for the pseudopodia. In its present mineral condition these tubules are seen to be filled with a siliceous mineral, while the calcareous matrix remains unaltered. The structure is thus preserved, and is described by Dr. Carpenter as exactly corresponding with that observed in the chamber-walls of recent Nummulites.

Messrs. King and Rowney, however, interpret this structure quite differently. They say that these "chamber-walls" are merely layers of Chrysotile,—a finely fibrous variety of Serpentine,—and they advance several facts in support of their view, of which we must be content to mention a few. They assert, for instance, that the "asbestiform" character of this layer is not constant, that it is sometimes uniformly and finely fibrous, but often composed of bundles of alternately coarse and fine fibres, while specimens occur

* 'Quarterly Journal of Science,' No. 6, April, 1865: "Chronicle of Geology."

in which two distinct "asbestiform layers" are seen superimposed on one another, and again in which the fibres are in some places parallel and in others divergent. They also raise a much more important issue: they say that the fibres are indefinitely fibrous, in other words, that each fibre, when examined with as high a power as is practicable, is resolved into fibres, each similar to what the original fibre itself appears to be under a lower power. They therefore consider this "asbestiform" layer to be of inorganic origin, and composed of chrysotile or some similar mineral.

Messrs. King and Rowney meet Dr. Carpenter on other grounds, without, in some cases, knowing that the points had been raised by the latter naturalist. But it would be tedious to mention all the structures which are differently described by the advocates of the opposite views, so we refer those interested in the subject to the papers themselves.

Treating the question geologically, Messrs. King and Rowney state that they have observed the same structures in serpentinous limestone of Laurentian, probably Cambrian, Lower Silurian (Connemara), possibly Devonian, and certainly Liassic (Skye) age, and they ask how this fact can be reconciled with its organic origin? The answer to this question might not be difficult; but we must confess that the remarkable fact of Eozoonal structures being found only in serpentinous limestones, and not in pure limestones, to which Messrs. King and Rowney also draw attention, is a far greater anomaly. According to Dr. Carpenter, however, Dr. Dawson has at last succeeded in detecting Eozoon in pure limestone.

Whichever way this question of the origin of *Eozoon* may ultimately be solved, we cannot help thinking that Messrs. King and Rowney's paper will have done a great deal to extend our knowledge of the structure of the fossil, and to permanently enhance their own reputation.

In a paper "On the Kainozoic Formations of Belgium," Mr. Godwin-Austen disputes the truth of the distinction which has been drawn between the subdivisions of the Belgian crag, and propounds the view that although they may have been produced "under slightly differing conditions, and in sequence, yet in the horizontal sections they replace one another." He also endeavours to show the inapplicability of percentage calculations as a means of determining the relative ages of these deposits, on the ground that while the fossils of the lower, or Diestien, beds, are proper to them, those of the upper, or Scaldisien, beds, are wholly extraneous, belonging to all regions of depth and all periods of the crag-formation. The conclusion is therefore inevitable that although the Diestien fossils may enable us to infer the condition of that part of the crag sea at a particular time, the Scaldisien fossils are no guide whatever in geological chronology. Mr. Godwin-Austen also discusses several collateral questions, which we have not space to notice.

There are three papers on Post-pliocene Geology, namely:—

1. On the Formation of Lake-basins in New Zealand, by Mr. W. T. Locke-Travers.

2. On the Occurrence of dead Littoral Shells in the Bed of the German Ocean, forty miles from the coast of Aberdeen, by Mr. Robert Dawson.

3. On the Glacial Phenomena of Caithness, by Mr. T. F. Jamieson.

The third paper is by far the most important, as in it Mr. Jamieson shows that the glacial phenomena of Caithness differ remarkably from those observed in the midland region of Scotland, especially in the direction of the glacial markings, which point with great persistence from N.W. to S.E., or thereabouts; that is to say, from the open sea towards the interior instead of *vice versâ*. The author is therefore of opinion that the glaciation of the Caithness rocks has been produced by a movement of ice from an external region to the north-west; and from the abundance of marine shells in the drift it is probable that it was accumulated by the agency of marine ice. In these respects the traces of glacial action present a very strong contrast to those observed in central Scotland, as will be seen by a reference to former Chronicles.

The distinction is further borne out by the absence from Caithness of tranquilly deposited glacial-marine beds, of valley gravel, and of moraines and gravel hillocks. The area over which these peculiarities extend has not yet been determined, nor has the relative age of the shell-bearing boulder-clay; but it is probable that this is more recent than the true boulder-clay of central Scotland.

Mr. Locke-Travers's paper is occupied with a statement of facts tending to show that Dr. Haast's views of the formation of the New Zealand lake-basins are not borne out by actual phenomena; and Mr. Dawson's note is a record of the remarkable fact stated in the title.

The last paper in the Journal, entitled "On the Carboniferous Slate (or Devonian Rocks) and the Old Red Sandstone of South Ireland and North Devon," by Mr. J. B. Jukes, is of extreme interest to British geologists from its containing a new interpretation of the rocks of Devonshire; we must therefore devote the rest of this Chronicle to its consideration.

Geologists have hitherto considered that the strata of North Devon belong to the "Devonian Rocks," or marine equivalent of the Old Red Sandstone, and that in proceeding from Lynton to Barnstaple successively higher portions of the series were reached, there being a conformable dip southwards for the whole of the distance. In the south-west of Ireland there is a different set of rocks from what have hitherto been supposed to exist in North Devon. There a formation known as the Carboniferous Slate occurs, reposing conformably on the Old Red Sandstone, and itself as conformably overlain by Coal-measures. In some districts Carboniferous Limestone occurs above the Carboniferous Slate, but then the latter is much thinner than when the former is absent; and, generally, when one of these two formations is most developed the other is either entirely absent or very thin, so that a general section may be drawn, having at one end Carboniferous Slate reposing on Old Red Sandstone, at the other Carboniferous Limestone on the same base, and in the centre a thinner development of both Carboniferous Limestone and Carboniferous Slate, the latter (being the lower rock) reposing as before on Old Red Sandstone.

Now, in this paper Mr. Jukes endeavours to show that the Devonian rocks of North Devon are the same, stratigraphically and lithologically, as the Carboniferous Slate of the south-west of Ireland; and that, instead of there being a conformable and uninterrupted succession of rocks from Lynton to Barnstaple, the series is repeated, owing either to a reversed anticlinal, or (what he thinks more probable) a great east and west fault running through the centre of North Devon, and having a downthrow to the north. At any rate, he considers that the rocks of Baggy and Marwood are the same as those of Lynton, and he suggests the only two possible modes of explaining the circumstance, seeing that the dip of the beds is, to all appearance, persistently south.

VII. MINING, MINERALOGY, AND METALLURGY.

Mining.

The condition of British mining is far from promising. The continued low prices of copper and tin press very heavily upon our mines, which are now, in nearly all cases, worked to great depths, and necessarily at heavy costs. The wages of the miners in Cornwall and Devonshire are reduced, and as there is but little prospect of improvement for some time to come, emigration is taking place to an unusual degree. This is much to be regretted, as the ablest men are those who emigrate, and we can ill afford to lose this class of labourers. The 'Mineral Statistics' recently published put us in possession of the results of our mining operations during 1865. Out of 619 mines which have been recently in activity in Cornwall and Devonshire, we find that 238 have suspended operations, and we learn that several others, and unfortunately some of those mines employing the largest numbers of people, are to be closed shortly.

The premonitions conveyed by these unfortunate results cast a gloom over all mining operations; but, unfortunately, those interested in the mines cannot be persuaded to adopt the only step by which they may mitigate the evil under which they groan. At present the supply of tin and copper ores is beyond the requirements of the smelters, and therefore they purchase only at the lowest prices. These prices are not renumerative, consequently nearly all the mines are now working at a loss. Yet they struggle on, because the managers and the mines would be thrown upon the cold mercies of the world if the works were abandoned. Thus, our tin mines, especially, are producing far more tin than is wanted, and a glutted market necessarily compels low prices. This state of things cannot long continue: slowly, reluctantly, one mine after another is suspended, and real distress is staring a most industrious population in the face. Our young and able miners are emigrating; our older men suffer without murmuring, and hope for better days. (Since the above was written there has been an advance in the price of tin ore to the extent of 7*l.* 10*s.* the ton, and a small advance upon copper. The natural result of this is to induce a more cheerful spirit. It is also satisfactory to note that the miners instead of emigrating are now seeking and finding employment in the colliery and other districts.)

The quantity of tin ore raised in 1865 was 15,686 tons, from which 10,039 tons of metallic tin were obtained; within the same period we imported, principally from the Dutch settlements in the Eastern Archipelago, 5,699 tons of tin and 639 tons of tin ore and regulus.

There were 203 copper mines in the United Kingdom sending copper ore to market during 1865. These produced 198,298 tons of ore, from which were smelted 11,888 tons of copper of the value of 1,134,644*l.* It appears, however, from a table given in the 'Mineral Statistics,' that the price at which the ore sells, and the produce of the ores raised, have for many years steadily declined. There has been, for some considerable time, no important discovery of any new deposits of copper, we may therefore infer that copper mining in these islands has seen its best days. Our importations of copper in 1865 were very large. From our Colonies and Foreign parts we received 82,562 tons of copper ore, 39,686 tons of copper regulus, and 7,026 tons of copper in bricks and pigs. If we were to draw our conclusions from the statements given of the public sales of copper ores, we should naturally say that the imports were steadily declining. The Foreign and Colonial ores sold in 1856 being 28,997 tons, against 16,332 sold in 1865, but it must not be forgotten that 66,230 tons of copper ore passed into the hands of the smelters by private contract purchases. This is, in many respects, an unfortunate state of things; the only benefit arising from this system, to balance numerous disadvantages, being to establish more securely the monopoly of the copper smelters.

The British isles produced of lead ore 90,452 tons, the value of which was 1,153,154*l.*; from this was obtained 67,181 tons of lead and 724,856 ounces of silver, the value of the lead being 1,433,161*l.*, and that of the silver being 199,335*l.*

Passing from silver to gold, we find that the Welsh mountains produced in 1865 1,664 ounces and 11 dwts. of gold. It would be interesting to know at what cost this gold was obtained. Of zinc ores we appear to have produced 17,842 tons, and of iron pyrites (*sulphur ores*) 114,195 tons.

By far the most important of our mineral products remain to be noticed. Our coal and our iron must, at present—view them in whatever light we may—be regarded as the mainstays of our manufactures and of our commerce. In 1865 we had 3,256 collieries at work, and from them we drew the enormous quantity of 98,150,587 tons, of this we exported 9,170,477 tons, retaining 88,980,110 for home consumption. Of this it appears that 14,457,762 tons were used in making 4,819,254 tons of pig iron, and 14,325,390 tons employed in converting this into merchant iron. Our purpose in this place is merely to chronicle facts as they arise; we could have commented on the appointment of the Royal Commission to inquire into the duration of our coal fields, and other matters connected with this subject, had they not been treated fully in another division of our Journal.*

It may be incidentally stated that we learn the labours of the Royal Commission have been divided amongst several committees, who are to consider:—

1. The waste of coal in getting.
2. The waste of coal in consumption.
3. The depth to which collieries may be worked and ventilated.
4. The existence of coal under the Eastern Counties.
5. The statistics of produce—trade and manufacture.

The extension of our coal fields being committed to the charge of the Geological Survey.

The total value of our mineral productions is thus given in the 'Mineral Statistics':—

Total value of Minerals, 32,359,105*l.*

The total value of the Metals obtained from the metalliferous ores of the United Kingdom being . . .	£15,773,287
The value of the Coal raised . . .	24,537,646
Earthy Minerals, not including CLAY or BUILDING STONES	1,434,496
	£41,745,429

* "Our Coal Resources and our Prosperity," Art. I.

being the money-worth of the productions drawn from our rocks. To this must now be added the mineral oils produced in this country from the bituminous shales and cannel coal. The value of those mineral oils has not been given by Mr. R. Hunt, but we have every reason for believing that it does not fall short of three millions sterling. If therefore to the above we add this and the estimated value of our clays, bricks, slates, and building stones, we cannot estimate the mineral wealth of the United Kingdom at the present time at less than fifty millions sterling.

The necessity of working our collieries with economy is forcing —more and more—upon the attention of our coal proprietors the application of machinery for cutting coal. We have already described several of those machines; some of which are, we believe, doing their work effectively. We cannot afford space in this Journal for any long descriptions of machines, howsoever ingenious they may be, which have not received the test of a sufficiently long experience in actual working, to determine their merits.

Our attention has been called to a new hydraulic coal-cutting machine manufactured by Messrs. Carrett, Marshall, and Co., of Leeds. The machine is described as automatic, of three-horse power, and cutting at the rate of fifteen yards per hour, four feet into or under the coal, and at any height or angle, and at once going over. It uses in this work thirty gallons of water, making fifteen strokes a minute at a pressure of about 300 lbs., the cutting tools displacing only three inches of the coal so undercut. There are doubtless many advantages in the use of hydraulic power rather than that of air. In one case the power can be conveyed without loss; in the other the loss of force is great. This machine was highly spoken of at the recent Meeting of the British Association.

Messrs. Pigott and Farrar, of Barnsley, are said to have made some great improvements in a machine for pumping or compressing air for working coal-cutting machines, or for propelling engines of any kind used in a colliery. We also hear of a new coal-cutting machine, the joint invention of Mr. Gillett, mechanical engineer, and Mr. E. Beecher, the colliery engineer at the Thorncliff and Chapeltown Collieries. When these machines have had a sufficient trial we may again return to a consideration of them.

Mineralogy.

M. Pisani having received a black Spinelle from Haute-Loire, through the attention of M. Bertrand de Lorn, has submitted it to careful examination, and communicated the results to the Academy of Sciences of Paris, through M. Ste. Claire-Deville. This black Spinelle has been found principally in the Haute-Loire, but it has been met with in Cantal and the Puy-de-Dome. It is found in the igneous rocks of the Auvergne, spread in black octohedral crystals in the fissures and small cavities. It is also found in the detritus from the disintegration of these rock masses.

The analysis of this mineral is, as given by M. Pisani:—

Alumina	59·06
Ferric Oxide	10·72
Ferrous Oxide	13·60
Magnesia	17·20

which gives the formulæ $Mg\,O\,Fe\,O, Al^2 O^3 Fe^2 O^3$.

This composition is that of a true Pleonaste, which is a black variety of the Iron and Magnesia Spinelle. But this variety is rendered remarkable by its crystalline form—an octohedral pyramid —which has not until now been recognized in any of the Spinelles.

Some remarkable discoveries of Native Lead have been made lately in Victoria, Australia. It is found associated with gold and oxide of iron in the gold drifts, under the basalt, and in the neighbouring veins containing Galena. Specimens have been forwarded to Mr. R. Brough Smyth, the Inspector of Mines at Melbourne. The first samples were from a "lead" at Mount Greenock, near Talbot, where they are said to be numerous. The second series of specimens came from the main "lead" at Aorca, where they are obtained from nearly every part of the "wash dirt." Mr. R. Brough Smyth informs us that, when carefully analyzed, he intends to forward the specimens, with a description, to the Geological Society.

From one of the journals published at Auckland, we learn of a valuable discovery of Bismuth in New Zealand. This metal is associated with copper, and by some novel process, it is said, the copper and the bismuth are economically separated from each other.

The production of the diamond by artificial means is once more attracting attention. M. de Chancourtois, in a paper read before the Academy of Sciences of Paris, announces that he has obtained, in a little more than twenty years, small crystals of diamond, by very slowly decomposing sulphide of carbon, by tin excited by a very weak electrical current. M. Elie de Beaumont has made a communication on the subject to the Academy.

Professor A. H. Church communicates to the 'Chemical News' the discovery of *chloropal* abundantly in a quarry close to the old tin mine of Carclase. "The *chloropal* occurs with Fluor in the fissures of the granite, and resembles that variety of chloropal which has been termed "gramenite," from Menzenberg near Bonn."

In 'L'Institut' for June is an interesting paper by M. Goebel, "Researches on the Carnalite, and upon the Red Coloration of certain Minerals." This paper was read before the Academy of Sciences of St. Petersburg. We must refer our readers to the original, as it will not bear abstracting. Professor Shephard, in 'Silliman's Journal,' vol. xl., p. 110, announced the discovery of a new mineral *Syhedrite*, and L. S. Inglestrom, in the 'Journal fur Praktische Chemie,' vol. xcvii., writes of *Kondro-Arsenite* as a new mineral, but this requires confirmation.

Metallurgy.

Mr. C. Cochrane, of Dudley, has patented a process for separating dust from the gases evolved from blast furnaces. This in many cases is so great as to considerably interfere with the economical application of those gases. Mr. C. Cochrane proposes to construct a cylindrical chamber into which the gases pass, entering at the upper end, and descending and passing off at the lower end, of such chamber. In this chamber are numbers of parallel partitions, so arranged as to come below the open spaces in the partitions above. By passing through those partitions, the gases are filtered of the dust they hold suspended. We fear some difficulty may be experienced in getting the gases to pass against the action of gravity.

At the present time few things are attracting more attention than the use of anthracite in the manufacture of iron. In America for a long time this fuel has been employed, but not, as it appears, with anything like the economy which has been recently obtained by Mr. Samuel Blackwell, of the Yniscedwin iron works, in South Wales. For some weeks past the results upon a new blast furnace, constructed after many experiments, have been the production of 1 ton of pig iron with 18 cwt. of coal in the furnace. This is, we believe, the greatest economy which has as yet been effected in the make of iron, and this anthracite iron is said to possess properties which render it peculiarly valuable for steel making.

Messrs. Vivian and Sons, of the Llandor smelting and alkali works, Swansea, appear to have been eminently successful in their application of the new furnaces—Gerstenhofer's patent—for the combustion of the sulphur, sublimed from the copper ores, and the conversion of it into sulphuric acid.

If this process is adopted at all the smelting works, Swansea will be relieved from the cloud of copper smoke which is ever hanging over it, and many thousands a-year will be saved by the conversion of the sulphur now wasted into an article which is in extensive use in manufactures.

VIII. PHYSICS.

LIGHT.—Professor Roscoe, of Owens College, writes us that in the last number of our Journal, in an article on De la Rue and Celestial Photography, the author has unwittingly done him an injustice in attributing to him the claiming of a discovery which was already known. Referring to the statement as to the well-known difference between the intensity of light from the centre and from the border of the sun's disc, Dr. Roscoe writes, "What I believe to be original in my communication, is the *numerical determination* of the amount of a difference which has been long observed."

Dr. Memorsky and Professor Brucke, in a paper communicated to the Vienna Academy, describe diffuse daylight as strongly reddish, just as gas or lamplight is yellow. The only perfectly white light, they tell us, is the electric light from charcoal points. The light of burning magnesium, and the combustion of phosphorus in oxygen, they say are violet.

M. A. Bertin has examined the constitution of glacier ice by polarized light. He has found that the superficial part of the higher glaciers is composed of agglomerated snow; but lower down, where the water has sunk into the fissures and become frozen, crystallization and true ice are found.

Professor Bunsen has made a discovery in connection with the absorption-spectrum of Didymium which may prove of great theoretical importance. In a paper which he published in conjunction with Professor Bahr some time ago, it was shown that slight differences were observed in the absorption-spectrum of sulphate of didymium according as the light was allowed to pass through a crystal or through a solution of the salt. Since that time Professor Bunsen has found that the erbum and didymium spectrum undergo alteration if polarized light be employed and either the ordinary or the extraordinary ray be allowed to pass through the crystal. It has also been found that whilst, when spectroscopes with one prism and with a telescope of moderate power are employed, the spectrum of the various didymium compounds do not show any difference, yet most undoubted differences are noticed when more powerful instruments are used. These differences cannot, in our present complete state of ignorance of any general theory for the absorption of light in absorptive media, be connected with other phenomena. They remind one of the slight and gradual alterations in pitch which the notes from a vibrating elastic rod undergo when the rod is weighted, or of the change of tone which an organ-pipe exhibits when the tube is lengthened. These curious phenomena form the subject of a long paper by

Professor Bunsen, which appears in the September number of the 'Philosophical Magazine.'

Heat.—According to some experiments made by M. Gripon on the conducting power of Mercury for heat, it appears that if the conducting power of silver = 100 that of mercury = 3·54. It stands therefore the last of the metals, and a little before marble or gas coke. The author mentions that in this case the conducting power for heat and for electricity is very different, the former being 3·54, and the latter 1·80.

Although scarcely coming under the heading of "Heat," yet as they point to a possible means of storing up heat and force for future use, we give here an abstract of Professor Graham's most remarkable discovery in dialysis. The Professor finds that atmospheric air drawn through films of caoutchouc leaves behind a large portion of its nitrogen. The septum has no porosity, and is really impervious to air as gas; but the india-rubber film is capable of liquifying the individual gases of which the air is composed, whilst the oxygen and nitrogen, in the liquid form, penetrate the substance of the membrane *unequally*, and appear on the other side, where they again become gaseous. The rubber film thus becomes a dialytic sieve for atmospheric air, and allows very constantly 41·6 per cent. of oxygen to pass through instead of the 21 per cent. usually present in air. This dialysed air rekindles wood burning without flame, and in many other respects can replace pure oxygen for laboratory and technical purposes.

Electricity.—The electro-chemical properties of Magnesium have been applied to a very useful purpose by M. Roussin. Hitherto, in the toxicological examinations for metals, zinc has been exclusively employed, but this metal, as met with in commerce, is always impure, and the employment of magnesium has now been proposed as a substitute. Magnesium has the double advantage of rapidly and completely precipitating poisonous metals, without the danger of introducing any other poisonous substance. Arsenic and antimony are not precipitated, but will be found in the gas disengaged and in the liquid remaining. The author destroys organic matter by the usual methods, concentrates the acid liquor, and then introduces ribbons of magnesium as long as any deposit is formed. This precipitate is washed and examined by the usual method for metals. If the operation be conducted in a Marsh's apparatus, the gases may at the same time be examined for arsenic and antimony. The magnesium now to be purchased, in the form of ribbon or wire, is almost perfectly pure, and its price is so moderate that this can be no hindrance to its general use in laboratories.

Some new electric batteries have been described by M. Mouthier.

In the first he uses sulphuric acid and iron. In a cylindrical vessel of iron he places a prism of carbon, and then pours in dilute sulphuric acid. The carbon and iron form the two poles. Two of such batteries are sufficient to cause the ordinary telegraphic bell to ring. The batteries are said to be cheap, inasmuch as the sulphate of iron produced may be used in another system, composed as follows:—In a cylindrical vessel containing a concentrated solution of protosulphate of iron, the author places a cylinder of zinc and a prism of carbon forming the two electrodes of the pile. The zinc dissolves, hydrogen is disengaged, and hydrated sesquioxide of iron precipitated. Two elements of this kind served for an electric bell for several months.

M. Zaliwski-Mikorski has announced to the French Academy that he finds smearing the zincs of a Bunsen's battery with grease will answer the same purpose as amalgamating them. The fact may be as he states, but certainly he is not very happy in his explanation when he says that the grease acts as a body rich in hydrogen; that is to say, as a combustible body.

IX. ZOOLOGY AND ANIMAL PHYSIOLOGY.

A Report of the Proceedings of the British Association at Nottingham in reference to the subjects of our Chronicle will be found elsewhere. The most remarkable feature in the Meeting in this regard was the advocacy of Darwinism by the President, Mr. Grove,—as part of the Law of Continuity then enunciated by him—and the general support which the theory of the Origin of Species by modification and descent received from the leading men of Section D.

We understand that it is proposed to hold an Anthropological Congress in Calcutta on a very extensive scale. The Government is intending to inaugurate an Exhibition of Arts and Manufactures in that city in 1869 and the members of the Royal Asiatic Society conceive that this will be a suitable and valuable opportunity for an exhibition of living men of various races. Calcutta is itself a city peculiarly fitted for such a gathering: in addition to the great variety of the tribes of the continent, individuals of whom are abundant within its walls, Chinese, Malays, Andamanese, Singalese, Polynesians, and Australians are to be found amongst the shipping, and no doubt a large number will be attracted by the exhibition. The Council of the Asiatic Society have accordingly addressed the Indian Government for assistance in carrying out their scheme, with a partial success, and there is every reason to believe that such an exhibition of men as was never before witnessed will be visible in

Calcutta in two years' time. It is intended to invite delegates from all the chief Scientific Societies of Europe, to assist in comparing, photographing, examining, and otherwise utilizing the collection of men when once assembled.

In our last Chronicle we noticed M. Paul Broca's researches on the site of the faculty of speech. We have now to record some observations by Dr. Gairdner, of Glasgow, confirmatory of M. Broca's conclusions, and touching on the question of the connection between the power of using words in speech or writing and the power of using them in thought. Dr. Gairdner describes several cases of the *Aphasic* state—Aphasia being the term introduced by M. Trousseau for that condition of inability to use words generally attacking the patient suddenly—which has been by others called Aphemia and Alalia. In these cases the persons frequently have the power of uttering an oath or ejaculation, or repeating what they have just heard, but otherwise are dumb. In one case the power of writing was tested, and the patient was found able to copy his name, but was utterly unable to write it from dictation. In these cases paralysis of the right side of the body is nearly always present, and diseases of the whole cerebrum, or of the left frontal portion only. A case observed by Dr. Sanders is particularly interesting. Aphasia had attacked a man who was otherwise quite intelligent. After some time he died; an examination of the brain was made, and disease was actually found only in the very part indicated by M. Broca's researches, *viz.* the external left-frontal convolution.

Dr. Gairdner discusses the question whether loss of intelligence necessarily accompanies Aphasia, and concludes that though such an effect need not occur immediately, yet the loss of the power of symbolizing thought by words must necessarily in time lead to this. M. Lordat maintains that in his own case he could think and arrange *ideas*, though he had lost the use of words. Dr. Gairdner thinks that such a power could not remain long. We have all heard, or perhaps known, what it is to think in a *foreign language*. The mere fact that people *do* this shows that the use of words as symbols is necessary in thought. The deaf and dumb have other symbols by which to think, not having been educated in the use of words. It is possible that some persons think *ideas* rather than words, but such thought can hardly extend to details. In the discussion on Dr. Gairdner's Essay, which was read to the Philosophical Society of Glasgow, Dr. Allen Thomson remarked, that the truth of M. Broca's observation was a death-blow to the assumptions of so-called phrenologists, since they placed the faculty of language over the eye, whereas the part of the brain indicated by M. Broca lay near the temporal fossa.

M. Marey, the able inventor of the Sphygmograph, has published an interesting and ingenious essay in Robins' 'Journal de l'Anatomie,' entitled "Pictorial Studies (*études graphiques*) on the Nature of Muscular Contraction." The instrument used in these investigations is called a myograph, and consists of a sort of spring clamp by which the muscle is lightly grasped and so arranged that any variation in the tension of the arms of the clamp shall effect the continuity of a galvanic current. The variation in the galvanic current is made to exhibit itself in the movement of a pencil, by which the myogram is written, as in the sphygmograph. Dr. Marey considers that voluntary muscular contraction is a complex phenomenon, resulting from the fusion of a series of successive "agitations." A muscular agitation is the movement which one observes under the influence of a single electric or traumatic excitation directed on a nerve or a muscle. It is most necessary to distinguish between this phenomenon and *contraction*, of which it is only an element, in the same way that a vibration is one of the elements of a sound. The characters of these muscular agitations can be determined by the myograph, and are found to vary under the influence of fatigue. A definite number is necessary to produce contraction of the muscle, but the number varies according to the animal and to the condition of fatigue. Helmholtz considered that 32 agitations in the second were necessary for tetanization, that is, complete contraction; but M. Marey shows that in a bird 75 may be necessary, and in a tortoise only 4. He regards the systole of the heart as a single "agitation" (*secousse*).

Dr. Charlton Bastian in the last number of the 'Quarterly Journal of Microscopical Science,' has entered into a minute description of the curious little granular bodies occurring on the surface of the brain, first described by Antonius Pacchionius, and known as Pacchionian bodies. Much laxity and carelessness has hitherto existed in reference to these bodies. By Pacchionius they were called glands, but this soon proved to be incorrect, though their true structure was never demonstrated. Many authors regarded them as arising from the *pia mater* beneath the arachnoid. Dr. Bastian shows that these growths are invariably developments from the visceral arachnoid, and has demonstrated that they have a complete epithelial covering and a fibrous structure agreeing with that of the arachnoid. Dr. Bastian's conclusions were anticipated to some extent by Ludwig Meyer, in a recent number of 'Virchow's Archiv.,' but this does not detract from the value of his independent research.

The second volume issued by the Ray Society to its subscribers for the year 1866, is a series of translations from the Scandinavian languages of recent memoirs on the Cetacea, by W. H. Flower, F.R.S. The first is "On the Greenland Right Whale" (*Balæna mysticetus*), by D. F. Eschricht and J. Reinhardt, originally published in 1861. No other complete description of the osteology of this most interesting animal exists, and hence the importance of the work. Mr. Flower further adds some notes on the skeleton lately acquired by the College of Surgeons. The second memoir is by the late Professor Eschricht "On the Species of Orca inhabiting the Northern Seas." He carefully decides on three species, instead of one only as had been supposed. The third memoir, on *Pseudorca crassidens*, is by Professor Reinhardt. He has given a careful and detailed description of the external and osteological characters of this remarkable form of Cetacean, hitherto only known by a skull exhumed from a fen in Lincolnshire, and therefore thought to have been long extinct. The sudden appearance of several individuals of this species on the coast of Denmark in 1862, shows how much may still be unknown of the Cetacean life, even in seas most frequented by civilized and observing man. The fourth memoir is by Professor Lilljeborg, "On the Scandinavian Cetacea." The most important novelties in it are the descriptions of two perfectly distinct species of large whales found in a subfossil state in Sweden.

The publication of a supplementary volume to Professor Hitchcock's great work "On the Ichnology of the Connecticut Valley" is of some interest. From various considerations adduced, such as the bird-like character of the foot markings, and the evidence that the individuals were quadrupeds, we must be fully prepared for the discovery of Reptilian Birds and bird-like reptiles, filling out the class Saurornia, lately proposed by Mr. Seeley to receive the Pterodactyls. Good evidence is now accumulating of many links between the reptile and bird, already considered as most closely related. We have a bird with teeth and a long tail and hooks on its wings, in the *Archæopteryx;* we have a reptile with wings and probably plumage in the *Pterodactyl;* and now it appears from the evidence of the sandstones of Connecticut, that there existed strange four-footed birds, the wings probably provided with feet at their extremities, also possessing long tails and covered with feathers.

In a late number of 'Wiegman's Archiv.,' Herr Elias Mecznikow describes some of his observations on the ciliated worms, or Turbellaria, in Heligoland. He has found that a very curious form, *Alaurina*, found by Busch at Malaga, and also by Claparede off Scotland, and considered by them as a larval form, is the representative of a distinct group among the Rhabdocœla, or straight-gutted Turbellarians. He met with similar forms in Heligoland: all were composed of four parts, of which the foremost was longest, the total length being only 1½ millimetres. The anterior part was furnished with a tactile proboscis, as in the animals of Busch and Claparede, whilst a long seta existed at the posterior end, and the body, of a pale-citron colour, was covered with a dense coat of fine cilia. The nervous system was obscure; the mouth, situated on the ventral surface, lead into a ciliated buccal cavity, which narrowed into a muscular pharynx; the intestine was straight and without any posterior orifice. On the two sides of the body were two very fine water-vascular stems. The genitalia were complete, This very interesting worm presents some analogies to the Cestoda, the jointed character of the body perhaps representing, as in that group, an animal colony.

We have to notice the Report of the Proceedings of the Bristol Naturalists' Society, from which it appears that this Society is in a very flourishing condition and doing much good work. Among the list of papers we notice particularly that of Dr. Henry Fripp "On the Eye of the Cepholopoda;" and that of Mr. A. Leipner "On the Asexual Reproduction of Cecidomya Larvæ."

We have also received the first annual Report of the North Staffordshire Naturalists' Field Club, which is a much younger society, and confines its exertions at present chiefly to excursions in the district. The President of this Society is Mr. James Bateman, F.R.S., while the Rev. S. T. Nevill, late of Magdalen College, Cambridge, is Treasurer. We may hope to chronicle important work done by this body of naturalists on some future occasion.

The Quekett Microscopical Club has issued its report for the past year, and numbers over a hundred members. The President for the ensuing year is Mr. Ernest Hart; the meetings take place once a month at University College.

Meanwhile the older and more scientific Microscopical Society of London is about to be incorporated as a chartered society, and members will enjoy the privilege of the use of the letters F.M.S. after their names.

At the late meeting at Nottingham a new half-yearly journal was announced, to be called 'The Journal of Anatomy and Physiology,' edited by Dr. Turner, of Edinburgh, Dr. Wright, of Dublin, Professor Newton, Professor Humphry, and Mr. Clarke, of Cambridge. Much may be expected from the high scientific characters of these gentlemen, and the enterprise of the publishers, Messrs. Macmillan. The journal is to appear twice a year, and to consist chiefly of original articles, to be largely illustrated by plates.

THE ASSOCIATION OF CERTIFICATED SCIENCE TEACHERS.

This Association, which was inaugurated at Birmingham in 1865, held its first Annual Meeting in Liverpool last July, and we are glad to find from the report forwarded to us by the Honorary Secretary, Mr. Mayer, F.C.S., of Glasgow, that it has met with the approval of the Committee of Council on Education.

The Association well merits the support of the State, and our new Ministry will do much towards attaining that popularity which is the legitimate ambition of all new Governments, by giving to it their best countenance.

At the Annual Meeting, presided over by Dr. E. Birkenhead, a Science teacher, the recently appointed Lecturer on Chemistry at the Liverpool Royal Infirmary School of Medicine, a number of useful resolutions were adopted, of which the following deserve special notice:—

1. That the Secretary should put himself in communication with publishers of text-books suitable for use in Science classes, requesting them to consider the propriety of granting such books on the most favourable terms possible to members of the Association, when they are ordered in quantities.

2. That, while regarding the Examiners in Geology and Physical Geography with all the respect that is due to their great eminence in their own special departments, the teachers interested in the examinations in those subjects in May last have some reason to regret that the examiners saw fit to draft such difficult examination papers as were given to the pupils, and to fix such a high standard, as the great percentage of failed candidates and the small number of first-class prizes awarded would seem to indicate.

3. That the Secretary should write to the Science and Art Department, and respectfully request:—i. That a careful revision be made of the syllabus contained in the 'Science Directory;' ii. That, as far as possible, each examiner shall name, after the syllabus of his own subject, the most suitable text-books to be used for that subject; iii. That the examination papers should be framed in accordance with the heads of subjects mentioned in the syllabus.

4. That the Council should recommend to the Secretary of the Science and Art Department, that certificates be awarded to all "passed" pupils, without any regard to the prizes at present given to first, second, and third class candidates.

We must confess that some of the questions asked by the Examiners have puzzled us not a little, and although the Examiner in Geography is no doubt entitled to the respect of the Science teachers, we have grave doubts whether he understands the capacity of the class of persons (the industrial classes) for whom his examination papers are framed, or he would not ask them to tell him what is the latitude of the mouths of the four largest rivers in China! We should like to have the information ourselves, merely out of curiosity, for it would not be of much benefit to us if we possessed it.

The heads of the Science Department will do well to encourage the Science Teachers' Association, for the gentlemen who constitute it are of the people and among the people, and they combine with a large amount of scientific knowledge a thorough acquaintance with the wants of the masses. They are far better able to advise those who have the disposal of the public money than scientific men, however eminent they may be, who are absorbed in their theories and researches, and are from their very pursuits unable to adapt themselves to the requirements of those whom the Science and Art Department is intended to benefit. We recommend the Council of the Association to make it as accessible as they can to the teachers, many of whom are not wealthy, and cannot afford to lay out much money without a tangible return; but if the subscription be low enough (and we really see no reason why it should be more than nominal), it ought to be, and no doubt will be, joined by every Science teacher in the three kingdoms.

The next Annual Meeting is to be held in Manchester.

Quarterly List of Publications received for Review.

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1. The Lake Dwellings of Switzerland and other Parts of Europe. By Dr. Ferdinand Keller, President of the Antiquarian Association of Zürich. Translated and arranged by John Edward Lee, F.S.A., F.G.S. 96 Plates. 420 pp. 8vo. *Longmans & Co.*

2. Tapeworms (Human Entozoa): their Sources, Nature, and Treatment. By T. Spencer Cobbold, M.D., F.R.S., Lecturer at the Middlesex Hospital. 90 pp. Fcap. 8vo. *Longmans & Co.*

3. Reliquiæ Aquitanieæ; being Contributions to the Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Part III. *From the Executors of the late Henry Christy, Esq.*

4. The Handbook of the Stars: containing the places of 1,500 Stars, from the first to the fifth magnitude, &c., &c. By Richard A. Proctor, B.A., F.R.A.S. Illustrated. *Longmans & Co.*

5. Cholera: What it is, and How to prevent it. By Edwin Lankester, M.D., F.R.S. *Routledge & Sons.*

6. Memoirs of the Geological Survey of Great Britain, and of the Museum of Practical Geology.—Mineral Statistics of the United Kingdom of Great Britain and Ireland for the year 1865. With an Appendix by Robert Hunt, F.R.S., Keeper of Mining Records. 315 pp. Royal 8vo. *Longmans & Co.*

7. Electricity. By Robert M. Ferguson, Ph.D., of the Edinburgh Institution. 148 Wood Engravings. 280 pp. Fcap. 8vo. *W. & R. Chambers.*

8. Vivisection: is it Necessary or Justifiable? Being two Prize Essays published by the Royal Society for the Prevention of Cruelty to Animals. 120 pp. Demy 8vo. *Hardwicke.*

9. A Dictionary of Science, Literature, and Art. Edited by the late W. T. Brande, D.C.L., F.R.S., and Rev. G. W. Cox, M.A. *Longmans & Co.*

10. Memoirs of the Geological Survey of Great Britain. The Geology of North Wales. By A. C. Ramsay, F.R.S., with Maps and Sections; and an Appendix on the Fossils, with Plates, by J. W. Salter, A.L.S., F.G.S. *Longmans & Co.*

PAMPHLETS, PERIODICALS, PROCEEDINGS OF SOCIETIES, &c.

On the Convolutions of the Human Cerebrum, topographically considered. By William Turner, M.B. Lond., F.R.S.E. *Edinburgh: Machlachlan & Stewart.*

Speech of H. Hussey Vivian, Esq., M P., F.G.S., On the Coal Question. (Delivered in the House of Commons, Tuesday, June 12, 1866.) *W. Ridgway.*

Statement by Mr. Ure on the Sanitary Scheme and Duties of the Medical Officers of Health. *Glasgow*, 1865.

Results under the last Bank Charter Act, 1864–6. By C. M. Willich. *Longmans & Co.*

Artisans' and Labourers' Dwellings Bill.

Sanitary Act, 1866.

Notes on the Foliation in the Gneiss and Schist of Yar-Connaught. By G. Henry Kinahan, Senior Geologist of the Geological Survey of Ireland. 20 pp. Demy 8vo. *From the Author.*

Reply to a Letter addressed to Malcolm Ross, Esq., President of the Manchester Chamber of Commerce. By John Dickenson, jun., Esq.; on the Subject of the Manchester Conference, January 24, 1866. By Robert Knight ('Times' of India). 13 pp. 8vo. *Johnson.*

American Journal of Conchology. Vol. I. Part 2.

A word on the Origin of Life. By James D. Dana.

On Cephalization. No. IV. By James D. Dana.

On the Future Water Supply of London. By Geo. Willoughby Hemans, C.E., and Richard Hassard, C.E. With Map. 32 pp. Demy 8vo. *Stanford.*

Address at the Anniversary Meeting of the Royal Geographical Society, 28th May, 1866. By Sir R. I. Murchison, Bart., K.C.B., &c., &c.

On Vitality. By Rev. H. H. Higgins, M.A. 19 pp. Demy 8vo.
Liverpool: Holden.

Notes on the Cells of the Bee. By Jeffries Wyman, M.D., Hersey Professor of Anatomy in Harvard College. 16 pp. Royal 8vo.
From the Author.

Chemical Addenda: Being a Brief Exposition of the Salient Features of Modern Chemistry. Designed as an Appendix to Elementary Text-books on the Science. By Rev. B. W. Gibsone, M.A., B. Sc. Lond., Lecturer in Chemistry at the City of London College. 20 pp. Fcap. 8vo. *J. H. Dutton.*

On the Application of Disinfectants in Arresting the Spread of the Cattle Plague and Cholera. Report to H.M. Commissioners. W Crookes, F.R.S. *Dutton, Wine Office Court.*

Further Observations on the Spectra of some of the Nebulæ, with a Mode of Determining the Brightness of these Bodies. By William Huggins, F.R.S.

A Discourse on Spectrum Analysis applied to the Heavenly Bodies. By W. Huggins, F.R.S., F.R.A.S. (British Association Lecture.)

Important on Cholera and the Public Health. By G. E. Waterton.

Cholera: Its Symptoms and Treatment. By A. O. Jones, M.D.
Jackson, Walford, & Co.

The True and False Sciences: A Letter on Homœopathy.
Churchill & Sons.

Report of the North Staffordshire Naturalists' Field Club. 1866.

Annual Report of the Board of Regents of the Smithsonian Institution; showing the Operations, Expenditures, and Condition of the Institution for the Year 1864.

Proceedings of the Bristol Naturalists' Society for Four Months ending April, 1866.

Bulletin Mensuel de la Société Impériale Zoologique d'Acclimatation.

Proceedings of the Chicago Academy of Sciences. Vol. I.

The Transactions of the Academy of Science of St. Louis. Vol. II., No. 2.

Journal de Médecine Mentale.

Canadian Naturalist and Geologist.

American Journal of Mining.

Geological Magazine.

Westminster Review.

Proceedings of the Royal Society.

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