Nature. Vol. XI, No. 269 December 24, 1874

London: Macmillan Journals, December 24, 1874

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THURSDAY, DECEMBER 24, 1874

PROTECTION FOR INVENTIONS

THAT most active and practical body, the Society of Arts, persevering in its endeavours to place our Patent system on an efficient footing, has devoted four evenings to the discussion of the question, the debate being led off by Mr. F. J. Bramwell, C.E., F.R.S., in a paper the ability of which has been warmly and justly extolled on all sides, alike by opponents and supporters, without a dissentient voice.

Mr. Bramwell, being circumscribed by the narrow limits of a short address, confined his attention principally to the question whether or not patents should be abolished. He probably foresaw that the discussion thus provoked would cover wider ground and examine the further question whether the system of patents, if preserved, does not admit of improvement. And it accordingly turned out so, for the latter question was much more fully discussed than the former.

The unanimity of opinion, indeed, as to the expediency of continuing to grant patents for inventions was most remarkable, the principal, if not the only dissentient, being Mr. John Horatio Lloyd, Q.C. This eminent legal authority, who in his evidence before the Parliamentary Committee urged the abolition of patents, now came forward, it is true, to declare that his opinions had undergone a change, and "expressed a reluctant acquiescence, though not a settled conviction, as to the expediency of protection for patents;" and he may therefore object to be ranked amongst the dissentients. We must refer to his speech as our justification for so placing him. This speech may be commended to metaphysicians, as throwing great light on the question whether the soul and the mind of man are distinct and separate. Mr. Lloyd's soul evidently hateth patents, but his mind perceives their necessity. His mind is only permitted to admit this necessity in the brief sentence we have quoted, and his soul then for the space of an hour employs every artifice of rhetoric to prove that the mind's admission is unwarrantable and unsound. In no other way can the discrepancy between the arguments and the conclusions be explained. It is impossible that they can both emanate from one and the same mind, and that an unusually acute mind. They issue, obviously, from two distinct and indeed antagonistic sources. It is not often that the spectacle is afforded us of a good and able man the helpless sport of a psychological contest. Mr. Lloyd's speech settled the main question. Skilful though it was, and delivered with the gentlemanly grace natural to him, the meeting was against him to a man, and listened to him, latterly, even with impatience. After he sat down, no one attempted the task, in which he had so signally failed, of proving that patents are injurious to the community, and, assuming them to be abolished, of providing an effective substitute.

The discussion then turned chiefly on the defects of the present English system and on the peculiar features of some foreign ones, particularly that of the United States, which was alternately approved and condemned. And here, as in mixed assemblages of Englishmen generally, there was much running after details, much reliance on illustrations, and but a small modicum of broad and systematic treatment. The point principally dwelt on was the necessity for a preliminary examination of patents. This, two members of Parliament—Mr. Hinde Palmer, Q.C., and Mr. Samuelson—informed the meeting, had been recommended by a Committee of the House of Commons on which both speakers had sat; but though some years had elapsed, no steps had been taken in the matter. Col. Strange caused a sensation by stating that the Patent Commissioners had applied to the Council of the Royal Society to nominate one of three eminent men of science who should perform this herculean task without salary, and that that learned body had, much to its credit, scouted the idea. This elicited strong expressions of opinion on the absurdity, injustice, and inexpediency of grudging to scientific men alone, of all those whose labours directly benefit the community, the liberal remuneration to which they are entitled. We have more than once brought this question before our readers, as one of those on which views are held in some quarters having a most prejudicial effect on those scientific reforms which are so urgently needed in England. We have never urged the proper remuneration of scientific labour on the grounds of mere philanthropic liberality to the labourer, but on the much higher ground that it is for the benefit of the nation materially, not less than for that of knowledge, that prospects should be held out of a career to those possessing talents and tastes for scientific pursuits. At present no profession, scarcely any occupation, holds out such small inducements to the rising generation of educated Englishmen as science. It needs no argument to prove that this passive discouragement of one of the spheres of intellectual activity most fruitful of advantages to mankind must have very injurious results, as we know from every-day experience that it has. We are glad to find that Mr. Bramwell, in his masterly summing up of the debate, ranged himself vigorously on our side of this important question; and it was with pain that we noticed expressions in the contrary sense, dropped, we trust inadvertently, by Mr. Samuelson, who, as a member of the Duke of Devonshire's Science Commission, must be well aware how much science suffers by the narrow neglect with which, as a nation, we treat the investigators of nature.

But to return to the question of a preliminary examination of patents.

There was some difference of opinion, though not of an irreconcilable nature, as to the expediency of this measure. It was too much assumed, even by Mr. Bramwell himself, that if such an examination were established here, it would necessarily be conducted in the same manner and with the same objects as in America—a perfectly gratuitous assumption. In America patents are examined mainly for novelty and utility, and are often rejected for failure in either respect. It is apprehended that, since inventors are often in advance of their age, an indiscriminate exercise of the power of rejection may retard the introduction of useful improvements — and several alleged instances of this were adduced. It is not always safe, however, to argue by illustration alone. The illustration may be inaccurately stated or wrongly applied, as in the case of one of those cited by Mr. Cole, who said that the power of rejection "would have prevented the building of the Crystal Palace, which wise men said must inevitably be blown down." The speaker no doubt had before his mind an imperfect recollection of the discussion which followed the reading of Mr. (now Sir Digby) Wyatt's paper on the first Great Exhibition building at the Institute of Civil Engineers in January 1851, when one "wise man," the present Astronomer Royal, objected to so purely rectangular a structure of iron, and insisted on the necessity for adding diagonal braces, giving at the time a full demonstration of his views. The question was one of Elementary Mechanics, which should have been better understood than it seems to have been. The "wise man" was right, as is proved by the adoption of his suggestion in the construction of the Crystal Palace; and his dictum, so far from retarding or preventing its erection, has probably saved that and similar structures from a hideous catastrophe. This is an instance of a wrongly applied illustration telling strongly against the argument it was intended to enforce. The power of rejecting patents is one, however, which, we fully admit, if conceded at all, should have its limitations, and should be exercised exceptionally rather than generally. But the staff which, under the American system, exercises this power, as some think too freely, is still indispensable for other purposes, as pointed out by Mr. Bramwell in his concluding address. They should, as a matter of duty, be ready and able to afford to inventors the fullest information, and should render them all reasonable assistance in steering clear of those shoals which must surround any patenting system. They should do this, not merely out of kindness to ignorant though ingenious inventors, but on behalf of the community, whose interest it is that a really useful improvement should be introduced in the most perfect possible shape. They should also revise specifications, which, often in ignorance, and sometimes from motives of questionable honesty, vaguely, imperfectly, or incorrectly set forth the invention. They would also sit with the judges on the trial of patent cases, affording that technical and scientific knowledge of the matters at issue in which it is admitted that both the Bar and the Bench are deficient.

In the consideration of this most important question, one of the uses of a well-organised patent system has hitherto been too little noticed—namely, that it may be made, both directly and indirectly, a powerful instrument of public instruction. A body of highly qualified responsible men, eminent in different departments of science and technology, acting in concert, and having at their command the resources and influences of a great department founded specially for introducing material improvements, including a complete collection of all the machines and appliances of manufacturing industry, and all the instruments and apparatus used in both abstract and applied science, which they should explain in public lectures, could not fail to disseminate widely that peculiar class of knowledge which it is found so difficult to engraft on any ordinary educational system.

Nor is this the only important point that entirely escaped notice in the recent discussion. The present constitution itself of the Patent Office was not challenged. It seemed to be considered that this having been, not very long ago, settled by a Committee of the House of Commons and an Act of Parliament, must be taken for granted as inevitable and unassailable. But fifty committees and acts of the Legislature should not suffice to preserve a constitution so inherently bad. What is it? The Patent Office is governed by four commissioners, the Lord Chancellor, the Attorney-General and the Solicitor-General for the time being, and the Master of the Rolls. Of these four, not one is presumably qualified by special knowledge, and three out of the four are liable to change frequently with changes of the Ministry. Nor is it even expected that any one of the four can or will give a moment of his time to Patent Office duties. The late Lord Chancellor candidly avowed to a deputation of the Society of Arts that he had never once entered the Patent Museum. The Master of the Rolls presides over perhaps the hardest worked court in the kingdom. And the two law officers, besides their duties as advisers to the Crown, are encumbered with their still more exacting duties to themselves as barristers in large practice. Notoriously and avowedly these four high legal functionaries leave the Patent Office to the care of its clerical staff. Should so monstrous an abuse be suffered to continue? Is it possible that, whilst it continues, necessary reforms will be introduced and efficient administration maintained? Nothing is more obstructive and more demoralising than a sham—and no worse or more glaring sham than this exists at the present day in a country in which shams are not very few or very retiring. The remedy is perfectly obvious. The Patent Office should be under a Minister of the Crown, directly responsible to the nation through Parliament for its good government. The Society of Arts have been for some time most properly urging that the Patent Museum, considerably expanded, should be placed under a Minister, with other Museums. Surely they cannot contemplate such a disruption of the whole system as would be perpetrated by placing the Museum under one authority, and the office to which it is an adjunct under another. We trust therefore they will insist that the whole system should be ministerially governed. For the present we abstain from indicating the particular Minister who should have charge of this and similar institutions, not because the appropriate arrangement is at all doubtful, but because our space to-day does not admit of our delineating it with the necessary fulness.

In conclusion, we hope that the unanimity in the late debate and in the press, in favour of retaining Patent Laws, will silence effectually the feeble cry for their abolition which from time to time contrives to make itself heard. No one can now, at any rate, be considered qualified to raise that question who has not read this discussion, and especially Mr. Bramwell's two closely reasoned masterly addresses.

LIVINGSTONE'S "LAST JOURNALS"

The Last Journals of David Livingstone in Central Africa, from 1865 *to his Death. Continued by a Narrative of his last moments and sufferings, obtained from his faithful servants, Chuma and Susi.* By Horace Waller, F.R.G.S., Rector of Twywell, Northampton. In two vols. With portrait, maps, and illustrations. (London: John Murray, 1874.)

THE opinion which we expressed of Dr. Livingstone's character and of the value of his work, when the sad tidings of his death reached this country last spring, is amply confirmed by the simple narrative before us. No one, we presume, who knows the work that Livingstone has done, and how he has done it, will hesitate to place him in the front rank of explorers, and award him a niche among the few whom men deem worthy of the highest and most enduring honour. It is, we believe, the simple truth to say that he has done more than any other man to fill up that vast blank in inner Africa which in the maps of twenty or thirty years ago was occupied only by the word "Unexplored" in large and widespread letters, delightful enough to the hearts of lazy schoolboys. Now, what with the labours of Livingstone in the south, and those of Baker, Burton, Speke, Grant, and others in the north and north-east, this blank space is reduced to a comparatively small circle around the equator on the 20th degree of east longitude. We have no doubt that within the space of the next twenty years, or less, the heart of Africa will be as fully and accurately mapped as that of South America, if indeed not more so. And when the geography of this region of the earth is complete; when science shall have been enriched with the knowledge of its multitudinous products organic and inorganic, when a legitimate commerce shall have brought its many blessings to the native population, who seem possessed of many capabilities for good; when Central Africa shall have taken its place among the civilised nations of the world—the memory of David Livingstone will be cherished by its peoples as worthy of the greatest reverence and gratitude. It will be long ere the tradition of his sojourn dies out among the native tribes, who, almost without exception, treated Livingstone as if he were a superior being; indeed, had it not been for the baneful influence of the Arab slave-traders, and the troubles which arose from the debased characters of the majority of his own retinue, Livingstone's last journey would have been one of comparative ease, would have been accomplished probably in about half the time, might possibly have been even more fruitful in results than it has been, and, above all, he himself might now have been among us, receiving the honours which he so nobly won.

As it is, we are thankful for the grand results that Livingstone has left behind him, which he achieved in the face of difficulties that would have daunted almost any other man, and which in the end brought himself to death; thankful are we also to the brave and loyal Susi and Chuma, who stuck so faithfully to their master, and preserved so religiously the invaluable record of his achievements. Their conduct has won for them the admiration of the civilised world, and their care for their master's remains has earned for them the gratitude of all Englishmen.

If this record of Livingstone's last wanderings is a sad one, it is not on account of any wailings that escape from the traveller himself. His journals were faithfully kept day after day, but the entries in them are brief, though pregnant. He wastes no useless words on his sufferings; nearly every sentence is a statement of an observed fact. Indeed, he distinctly says, when his difficulties began—and they began at the beginning—that he looked upon all his troubles as necessarily incident to the work he had set himself to do, and to be taken no more account of than the little difficulties which everyone must look for in carrying out his work in the world. Like all really great men, he did his work and made no fuss about it. Until near the end, when his sufferings must have been extreme, nothing like the cry of an afflicted man escaped him; his difficulties of all kinds were regarded merely as hindrances to the great work which he was so anxious to achieve. His journal is written in the simplest style, and never betrays any consciousness on his part that he was doing anything very extraordinary. His was no attempt to accomplish a mere traveller's feat; he had a definite task before him—the exploration of the lake region of Central Africa, a task which he never once lost sight of. True, in the end, his work concentrated itself on the discovery of the four fountains of Herodotus, which he expected to find away to the west of Lake Bangweolo, and among which he firmly believed he would find the long-sought-for source of the Nile. It was on the road to these supposed fountains that he died; had he lived to discover them or to disprove their existence, he would have considered his work as an explorer at an end, and would have returned to spend his remaining days at rest among his friends.

Livingstone's theories as to the sources of the Nile may very possibly turn out to be mistaken; but this can in no way detract from the value of his work. The "Nile mystery" cannot now long remain unravelled; but, compared with the large and substantial achievements of Livingstone, the solution of this is little more than that of an ingenious puzzle. Under all circumstances, Livingstone must ever stand forth as one of the world's greatest explorers, not only on account of his own immediate discoveries, but on account of the impetus which he has given to African discovery; for it is mainly owing to the enthusiasm generated by his noble example that so much has been done during the last thirty years to fill up the great blank on the map of Africa. His own travels, extending over a period of thirty years, embraced an area of some millions of square miles, reaching from the Cape to within a few degrees of the equator, and from the mouth of the Zambesi to Loango. And, as we have said, his aim was not to get over so much ground in the shortest possible time, and return to reap the reward of his feat. Like the native Africans, he travelled slowly and leisurely by short stages, mainly on foot, carefully and minutely observing and recording all that was worthy of note in the natural productions and phenomena of the region over which he travelled, studying the ways of the people, eating their food, living in their huts, and sympathising with their sorrows and joys. Already have various departments of science been enriched by his observations; and, what is perhaps of more importance, he has shown that in Africa a fertile field remains for the minute observations of the trained naturalist, ethnologist, geologist, and meteorologist.

It is impossible in the space at our disposal to give any adequate idea of the results of his last seven years' journeys. Indeed, as we have said, the records in his journals are so terse, there is so little of what is superfluous and so much of the highest value, that anyone wishing to have a satisfactory notion of what he accomplished must go to the work itself. Mr. Waller has wisely printed the journal as he found it, making no attempt at a systematic arrangement of the material; this will, no doubt, be done gradually, and the observations which he made day by day take their place in the various sciences to which they belong. We are glad to see from the preface that there still remains for future publication a valuable mass of scientific observations. "When one sees," to quote the preface, "that a register of the daily rainfall was kept throughout, that the temperature was continually recorded, and that barometrical and hypsometrical observations were made with unflagging thoroughness of purpose year in and year out, it is obvious that an accumulated mass of information remains for the meteorologist to deal with separately, which alone must engross many months of labour." We hope that no time will be lost in giving the world the benefit of this valuable material.

We shall briefly run over the ground traversed by Livingstone. He left Zanzibar on March 19, 1866, in the *Penguin* for the mouth of the Rovuma in about 10½° S. latitude. His company consisted of thirteen sepoys, ten Johanna men, nine Nassick (Bombay) boys, two Shapanga men, and two Wayaus (South Africans), Wekatani and Chuma. He had, besides, six camels, three buffaloes and a calf, two mules, and four donkeys. This seems an imposing outfit, and so it was, but it soon melted away to four or five boys. Rovuma Bay was reached on March 22, and a start for the interior was made on April 4. His course for the first three months was mainly along the banks of the river Rovuma, turning south-west after a march of about 300 miles, towards the south end of his own Lake Nyassa. On starting he has recorded some reflections on the advantages of travelling, which, for their own value and as giving an insight into the character of the man, we wish we had space to quote. The first part of his

A Fish-Eagle on Hippopotamus Trap.

course was through a dense jungle, and here the botanist will find some observations worthy of his attention. The gum-copal tree is here in great abundance, and some curious geological phenomena are noted. Ere he reached the Nyassa he had to send his sepoys back, as they were worse than useless; a set of lazy, degraded blackguards, whose brutal usage of the animals and that of the Johanna men, left him in the end with only his goats and a little dog. The Johanna men, ere they were well round the end of the lake, deserted,* and Livingstone was no doubt well rid of them, though it left him with so diminished a retinue that it made him dependent on native carriers, who were often difficult and expensive to procure. However, this was an evil that gradually lessened as he went on; for as he conscientiously paid his way wherever he went, his baggage was gradually diminished to no great bulk. In the first part of the route, also, the party frequently suffered from want of food, an evil which was of but too frequent occurrence during the long and intricate journey, not so much from unwillingness on the part of the natives to give or sell it, but simply because the brutal half-caste Arab slave-dealers, who were met with everywhere, had so desolated the country that the terrified and demoralised people were often themselves famishing. The horrors of this trade, "the open sore of the world," as Livingstone calls it, are shown on almost every page of this journal, and one of the sorest trials which the humane traveller had to endure

* It will be remembered that these men screened their cowardice by spreading a report of Livingstone's death.

was to be an almost daily witness of its inconceivable cruelties, and to feel himself powerless to help. Even in this matter, however, we believe his words and example will have had a good moral effect on many of the native chiefs, if not on the degraded dealers; for the people are so demoralised by the latter, that they hunt and sell each other. This Arab slave-hunting was a great hindrance to Livingstone's progress, as the dealers had so terrified the people as to make them suspicious of every stranger, and, with one or two creditable exceptions, did all in their power to poison the native mind against the white man, for they knew that he regarded their doings with unmitigated disgust. No good can come to Africa, and no exploration of her rich interior can be carried out with complete success, until this cruel traffic is abolished; and in the interests of science as well as humanity, we hope that the British Government will never cease to use its powerful influence until it is stamped out. We only wish that the Sultan of Zanzibar, whose subjects the half-caste traders nearly all are, could be induced to follow the example of the Khedive of Egypt, and depute some man of determination and vigour to sweep the interior of the entire horde of slave-hunters.

And here we cannot help saying that we almost wish that Livingstone had possessed some of Pasha Baker's wholesome sternness and disregard to the trivial scruples of his men and of petty village chiefs. It would have saved him many annoyances, and might in the end have been the means of saving his life. But he was so full of the great object of his mission that he did not care to waste the time and energy required to bring his low-minded sepoys and Johanna men under discipline; and his conscience was so tender, his humanity so strong, and his desire to live at peace with all men so much of a religion, that he would rather stay weeks at a village to suit the caprice of its childish chief than break away at the risk of giving offence or provoking hostility. His genuine tenderness of heart peeps out unconsciously every now and then, his charity was wonderfully wide, and his forbearance often almost annoying.

Lake Nyassa was reached on August 8, and passing down its east and round its south side, Livingstone struck out in a generally N.N.W. direction for the south end of Lake Tanganyika. We need scarcely say that this part of the journal, recording a journey through a country much of which had not hitherto been explored, is full of valuable notes on geology, botany, zoology, geography, topography, and the manners and customs and connections of the people. Here, as in almost every other part of his journey, the number of streams met with flowing into the great lines of drainage is astonishing; a dozen would sometimes have to be crossed in a day's march. After rounding the south end of Nyassa, however, he first met with those bogs, or earthen sponges, which abound also around Lake Bangweolo, and in the midst of which, and no doubt partly through their malarious influence, he died.

"The bogs, or earthen sponges, of the country," he says, "occupy a most important part in its physical geography, and probably explain the annual inundation of the rivers. Wherever a plain sloping towards a narrow opening in hills or higher grounds exists, there we have the conditions requisite for the formation of an African sponge. The vegetation not being of a healthy and peat-forming kind, falls down, rots, and then forms thick dark loam. In many cases a mass of this loam, two or three feet thick, rests on a bed of pure river-sand, which is revealed by crabs and other aquatic animals bringing it to the surface. At present, in the dry season, the black loam cracked in all directions, and the cracks are often as much as three inches wide, and very deep. The whole surface has now fallen down, and rests on the sand; but when the rains come, the first supply is nearly all absorbed in the sand. The black loam forms soft slush, and floats on the sand. The narrow opening prevents it from moving off in a landslip, but an oozing spring rises at that spot. All the pools in the lower portion of this spring-course are filled by the first rains, which happen south of the equator, when the sun goes vertically over any spot. The second, or greater rains, happen in his course north again, when, all the bogs and river-courses being wet, the supply runs off, and forms the inundation: this was certainly the case as observed on the Zambesi and Shiré, and, taking the different times for the sun's passage north of the equator, it explains the inundation of the Nile."

This is an important observation with regard to the Nile, though it may very well turn out that Livingstone himself was mistaken with regard to its source or sources. He found, as we have said, the same phenomenon in a much higher degree on the east and south sides of Lake Bangweolo, and believed it to be "the Nile, apparently enacting its inundations, even at its sources."

We wish we could linger with the traveller and speak in detail of some of the multitude of interesting observations he made as he sauntered along. The people themselves between Nyassa and Tanganyika are full of interest to the ethnologist, the sociologist, and the student of the ways of men. Their physique and intelligence are of a high order, and they have scarcely any of the negro characteristics. They are by no means savages, and in almost every village Livingstone was well and kindly treated by the chief and his people. There is no such thing as a national bond of union here, each village being a separate community, presided over by its chief. The region here, as everywhere else in Livingstone's journey, is thickly populated. The people are polite, industrious, and on the whole peaceful, the great disturbers of their peace being the Mazitu, a people to the north of Nyassa, who rove far and wide in search of slaves, leaving death and desolation in their track. The great industry here, and over a great part of the region visited by Livingstone, is the smelting and manufacture of iron, which is obtained in abundance from various ores. In this industry the people display considerable skill and ingenuity, and manufacture the metal into a great variety of implements, utensils, and weapons. Each tribe has its separate tattoo badge. The country itself, hilly, and well wooded, is of the most fertile kind, and abounds in buffaloes, elands, haartebeest, and other large animals, and evidently with not a few birds that are new to the zoologist.

(*To be continued.*)

INDIAN METEOROLOGY

Report of the Meteorological Reporter to the Government of Bengal for 1873. By Henry F. Blanford, Meteorological Reporter.

MR. HENRY F. BLANFORD'S annual Meteorological Reports for Bengal, of which this is the seventh, have come to be looked forward to with much interest by meteorologists, as not only model monograms of the subject discussed by them, but as further developing and occasionally opening up certain lines of inquiry which lead to practical applications of the science. In these respects the Report for 1873 is the best, as well as the most suggestive. Its outstanding feature is the discussion of the deficient rainfall of the Presidency during 1873, so disastrous by the famine which followed it; and the developing in the course of the discussion of a principle which, if confirmed by future observations, "will enable us to some extent to forecast our [Indian] seasons, or at least to speak with some confidence to their probable character for some months in advance."

From the increased number of stations now in connection with the department, and from the additional data obtained from the meteorological superintendents of the Governments of Ceylon, the Upper Provinces, Central India, and Berar, it is possible to form a conception of the geographical distribution of pressure, temperature, rain, &c., over one-half of India and its seas. The summaries of all the observations made over the region during the past seven years form an admirable feature of the Report. We very cordially join in the hope expressed that the observations which have been made in the Presidencies of Bombay and Madras will in future be accessible, and that those made in the Punjâb will be put on such a footing as to be trustworthy and comparable. As regards the last-named region, in all the annual reports we have seen (down to 1870) the barometric observations are given uncorrected for temperature and unaccompanied with the readings of the attached thermometer! When, on making the annual survey of the meteorology of India, the north-west, west, and south of the country can be included, it will be possible to write the history of the two monsoons of the year, and probably to point out the determining causes of their irregularities.

"The principal meteorological characteristics of the year 1873 were an excessive temperature, in Oude and the North-western Provinces more especially; an unusually low pressure of the atmosphere in the same region, and probably also in the south-east corner of the Bay of Bengal, while in Eastern Bengal pressure was persistently high; great unsteadiness in the winds, indicating the predominance of local causes in affecting the air currents, while the normal monsoon current from the south-west set in nearly a month later than usual, and ceased nearly a month earlier; lastly, a general deficiency of moisture in the atmosphere, as is betokened both by the hygrometric observations, the comparative absence of cloud, and the great deficiency of rainfall."

The usual characteristics of the Indian summer monsoon, based on the past seven years' observations, are thus stated:—

"In ordinary years the winds of the south-west monsoon blow, on the one hand from the Arabian Sea, on the other hand from the Bay of Bengal *towards a line lying to the south of the Ganges*, at no great distance, and parallel to that river. A barometric depression begins to appear in or near this region in April, and by the time the rains set in in June it is well established; the pressure decreasing along it from east to west where this trough, as it may be termed, merges in the great barometric depression of the Punjâb and the Bikaneer Desert. To the south of this line the winds from the Arabian Sea blow across the Central Provinces, chiefly from the west. To the north of it, those from the Bay of Bengal, turning with the Gangetic Valley, blow in an opposite, or easterly, direction, their line of meeting being along this trough."

Bengal being thus dependent, as regards its rainfall, on the aërial current which blows from the Bay of Bengal up the valley of the Ganges, it is evident that whatever weakens this current or directs it to the northward will have a serious influence on the rainfall. Now, in 1873 the trough described above did not occupy the usual position to the south of the Ganges, but a position considerably to the north-west, in Oude and Rohilcund, immediately under the hills. A change in the direction of the wind necessarily followed this change in the position of the area of lowest atmospheric pressure; and in strict accordance with the now well-known relation of wind to pressure, there was an unusual prevalence of westerly winds over the greater part of Bengal during June and July, and the rainfall consequently was deficient.

The observations made in the Andaman and Nicobar Islands show the existence of a barometric depression over the south-eastern portion of the Bay of Bengal, the effect of which would be to deflect a large portion of the monsoon current of the Bay of Bengal towards Sumatra and the Tenasserim and Burmah coasts. Thus, then, the monsoon current, on which Bengal is dependent for its rainfall, was not only deflected northward from its usual track during 1873, but was also weakened in force by being partially drained away to the south-east in the direction of Burmah.

In the examination of the rainy seasons of 1868, 1869, and 1873, Mr. Blanford has the merit of first drawing attention to the existence of local and persistent variations of pressure, which appear as a local exaggeration or partial suppression of the great annual variation—the pressure remaining for many months, sometimes through two or more consecutive seasons, either higher or lower than the average, relatively to other parts of the country, over a more or less extensive track. It is to these persistent irregularities in the distribution of atmospheric pressure that the irregularities in the distribution of the rainfall must be ascribed, and it is to the further investigation, by future observations, of the characteristic feature of persistency in this class of barometric variations that we look with hope to the realisation of a great triumph awaiting meteorology, viz., the prediction, for some months in advance, of the general character of the coming seasons of India, and thereafter a gradual extension of the principle to other countries.

As regards the humidity, the only data of observation published in the Report are the dry-bulb observations. To these are added the *computed* values for the elastic force of vapour and the relative humidity. In future issues of the Reports we should recommend that the wet-bulb observations be also published. In a country of such extreme climates as India, it is eminently desirable to have the whole *observed facts* relative to the humidity before us, particularly since, from the present defective state of our hygrometric tables as regards dry hot climates, computed values can be regarded only as rough approximations. In estimating the state of the sky, a clear sky is entered as 10, and a sky completely covered with cloud as 0. It might be well in future to adopt the recommendation of the Vienna Meteorological Congress on this head, by which a clear sky is entered as 0, and a sky completely covered with cloud as 10. The number of days at the various stations at which "a measurable quantity of rain fell," are given in Table XXX. The exact amount of rain constituting a rainy day should in future be stated. In Great Britain only those days on which at least 0·01 inch falls are regarded as "rainy days." We are glad to see that Symons' gauges (5-in. diam.) are adopted—this being the gauge best suited for general introduction—and that the height is a foot above the ground.

We have long been convinced that for a first satisfactory scientific discussion of some of the more difficult problems of the science we must look for the data of observation to India, with its splendid variety of climates, exposures, and abrupt mountain ranges and isolated peaks. The chief of these questions are, the variations in the daily march of temperature as dependent on season, latitude, height, and situation, both maritime and inland; the hourly barometric fluctuations (of which so little is really known), particularly as influenced by strong insolation, vapour, cloud, aqueous precipitation, and height either on extended plateaus or on hills rising abruptly from the plains; and the vital question of atmospheric humidity, to put which on a proper footing as regards hot dry climates, laboratory experiments being all but worthless, recourse must be had to extensive observations and experiments conducted under such conditions as are presented by the scorching climate of the Punjâb. In the further development of Indian and general meteorology, the establishment of a Physical Observatory in the Punjâb is urgently called for, as being, in truth, indispensable for the prosecution of these and other physical researches.

OUR BOOK SHELF

A Year's Botany, adapted to Home and School Use. By Frances Anna Kitchener. Illustrated by the Author. (Rivingtons: London, Oxford, and Cambridge, 1874.)

THIS unpretending little book is one that is sure to find its way wherever Natural Science is taught in the only way in which it is worth teaching, as a training for both the observing powers and the reasoning faculties. The greater part appeared originally in the *Monthly Packet*, and has been reprinted with additions at the request of friends more discriminating than is usually the case under such circumstances. We know of no book which we could more safely and confidently place in the hands of young people as their first guide to a knowledge of botany. The illustrations are from drawings from nature by the authoress, and are a pleasing change from those which have already done duty in so many text-books.

The following sentence, from the first chapter, illustrates the mode in which the writer conveys her instruction:—"But first I must beg that my readers will give me a fair trial; that they will pick the flowers described, and examine them *while* they read the description; and that they will trace every law, arrangement, and peculiarity in their living illustrations. Sometimes these may not be seen at the first glance, or even in the first specimen, but they must pick fresh flowers, look and look again, and *take nothing upon trust*, remembering that one of the chief lessons botany has to teach is how to use both eye and hand." Several typical flowers are then taken—the buttercup, wall-flower, cucumber or vegetable marrow, gorse, garden-pea, and primrose, and the various parts of each described in ordinary language, without the use of any technical terms. To these succeed separate chapters "On Flowers with Simple Pistils," "On Flowers with Compound Pistils," "On Flowers with Apocarpous Fruits," "On Flowers with Syncarpous Fruits," and "On Stamens and the Morphology of Branches." To each chapter is prefixed a list of specimens which will be required to enable the student to follow for himself the writer's analysis; the descriptions are given in an extremely easy and lucid style, a few of the commonest scientific terms—but as few as possible—being gradually substituted for the colloquial English phrases at first employed. A sufficient acquaintance having then been obtained with the morphology of the more conspicuous organs, and their functions at the same time explained, the phenomena of nutrition, respiration, and fertilisation, and the structure of tissues, are described in chapters "On Fertilisation," "On Seeds," "On Early Growth and Food of Plants," "On Wood, Stems, and Roots," and "On Leaves." A chapter is then given to classification, to which is appended some useful tables of the characters of the more important orders; and this is followed by two or three chapters devoted to a few of the more important natural orders, and intended to serve as an introduction to the mode of naming plants. The most commonly used technical terms which have not been employed in the work itself are explained in an appendix, in which the wants of students preparing for the University Local Examinations have been kept in view.

The mistaken plan on which many botanical text-books have been compiled is so largely answerable for the horror in which the subject is held by candidates for examination who endeavour to cram facts and technical terms in an incredibly short space of time, without an attempt at practical work, and in the end fail miserably, that we cordially welcome an attempt to place the study on its true footing. We entirely concur in the view of the writer, that to this false method is due the fact that "Botany is so often stigmatised as a dry, uninteresting study;" an opinion which would speedily disappear were her mode of instruction in general use in the family and the school. Mrs. Kitchener's "A Year's Botany" seems to us admirably adapted for the purpose which she had in view in publishing it, and we heartily desire for it a large circulation.

A. W. B.

Dental Pathology and Surgery. By S. J. A. Salter, F.R.S. (London: Longmans, Green, and Co., 1874.)

THERE is much in dental surgery besides the simple extraction of teeth, and it is to the consideration of the science of dental pathology that Mr. Salter devotes most of the work under notice. The introductory chapters treat shortly of structure and function, development being left out of consideration. An excellent diagram explains the relation of the tongue to the different parts of the mouth during the pronunciation of the various letters of the alphabet, which latter is arranged on a physiological basis, dependent on the situation of the point of closure by which the sound is produced, upon the completeness or incompleteness of the closure, and upon whether the breathing is soft or aspirate. To the purely physiological student the chapter on irregularities in the position and union of contiguous teeth will be of particular interest; as will the instances given of defects in their number depending on hereditary causes, and on alopœcia; to which we may add the peculiar deficiency always connected with the excessive development of hair over the face, as in the Russian man and child who so recently visited this country. The differentiation off from pure surgery of a class of tumours which, before Mr. Salter's investigations, were considered to belong to the bones themselves, and which, as odontomes, are now known to be composed of secondary dentine, will be specially instructive to the pathologist, as will the question of reflex nervous phenomena, such as partial paralysis and blindness, from the irritation of a diseased tooth. A full and very instructive account is also given of "phosphorus disease," which attacks in so painful a manner the manufacturers of lucifer matches, and which can be so completely obviated by the employment in their construction of red instead of ordinary phosphorus, because the former does not give rise to the formation of acid fumes when exposed to the air, and therefore does not attack the mouth and teeth. There is one subject on which we have looked, but in vain, through this volume for information: it is for the explanation of how it is that tooth-disease and civilisation so unfortunately go hand in hand. The work will be found of special interest to all students of surgery.

LETTERS TO THE EDITOR

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

Deep-sea Researches

WHEN Prof. Wyville Thomson published his recent volume giving the results of the deep-sea researches conducted by himself and his colleagues, Dr. Carpenter, Mr. Jeffreys, and others, he also gave a sketch of the history of the subject; but he made no mention of my memoir on the Microscopic Organisms of the Levant Mud, published in 1847 in the Transactions of the Literary and Philosophical Society of Manchester, though this memoir had been referred to from time to time by Dr. Carpenter, Messrs. Parker and Rupert Jones, and others, and was, next to Ehrenberg's discovery of the microscopic structure of chalk, the starting-point of all these deep-sea investigations. It was the first to call attention to the existence of foraminiferous deposits in the sea, and to insist upon the organic origin of *all* limestones except a few freshwater Travertins, in opposition to the theory of chemical deposits that had previously been advocated in the works of Phillips and other geologists. I do not care very much about these questions of priority of observation, but since Dr. Wyville Thomson's article in NATURE, vol. xi. p. 116, dwells largely upon another point, which was also brought prominently forward in my memoir, I think it worth while preventing a repetition of the oversight, because the two subjects referred to, viz. the foraminiferous origin of calcareous deposits, and the subsequent modification of such deposits by the agency of carbonic acid gas, now prove, as I long ago insisted that they would do, two of the most important factors in the solution of the problem of the nature and origin of deep-sea deposits. Dr. Wyville Thomson, in the article in question, points out that extensive areas of the deep-sea bottom are now occupied by a reddish earth, and he has arrived at the conclusion that this earth is a residue left after all the calcareous Globigerinæ and other such elements have been removed by the solvent action of carbonic acid accumulated in these deep waters. In my memoir I arrived at the same conclusion from the study of the marine Tertiary deposits, containing Diatomaceæ, of Bermuda, Virginia, and elsewhere. I may perhaps be permitted to republish the following extracts from that memoir, since it is not now readily accessible to all the numerous naturalists who are interested in this question:—

"In the recent deposit of the Levant we have generally an admixture of calcareous and siliceous organisms. In some localities the latter are more sparingly distributed than in others; in a few instances they are almost entirely absent. The same admixture occurs in the recent sands from the West Indies. The soft calcareous mud from the bottom of the lagoons of the Coral Islands contains a considerable number of similar siliceous forms, and corresponding results have been obtained in most of the marine sediments from various parts of the globe, examined by M. Ehrenberg.

"On the other hand, the infusorial deposits of Bermuda and Virginia are altogether siliceous. Not one calcareous organism exists. The siliceous forms comprehend the majority of those which I have described from the Levant, many of them being not only *similar* but specifically identical, and the manner in which they are grouped together in these distant localities indicates something more than mere accident. Indeed, we want nothing but the calcareous structures to render these Myocene strata perfectly analogous to those now in process of formation both in the Mediterranean and in the West Indian seas. Are these siliceous deposits, so void of any calcareous organisms, still in the condition in which they were originally accumulated? or were they once of a mixed character, like those of the Levant, having been subsequently submitted to some chemical action which has removed all the calcareous forms, leaving only the siliceous structures to constitute the permanent stratum? I am disposed to adopt the latter opinion, for several reasons."

After showing the resemblance between the residue left after treating certain substances with nitric acid, and the diatomaceous deposits, I proceed to say:—

"Such deposits, in these present conditions, stand out as anomalies in the existing order of oceanic phenomena, and have nothing resembling them except the local freshwater accumulations which occur in various places. Between these, however, no real analogy exists. It must not be forgotten that the Virginian deposit can be traced for above two hundred miles; and, being marine, would doubtless be mixed up with such marine products as were likely to occur along so extended a line. The only recorded instance with which I am acquainted, that exhibits the slightest resemblance, is furnished by M. Ehrenberg, in his examination of materials brought home from the south pole by Dr. Hooker. Some pancake ice, obtained in lat. 78° 10', long. 162° W., when melted, furnished seventy-nine species of organisms, of which only four were calcareous Polythalamia, the remainder being all siliceous. But even this example, remarkable as it is, does not supply us with any real parallelism. The deposits in question have never yet exhibited a single example of a calcareous organism."

After referring to the European greensands, I continue:—

"Nature furnishes us with an agent quite equal to the production of such effects as we are at present acquainted with. This is carbonic acid gas in solution in water. Mr. Lyell has already availed himself of the instrument to account for the subtraction of calcareous matter from imbedded shells, as well as for some of the changes that have taken place in the structure and composition of stratified rocks . It is easy to conceive that whilst these strata were in a less consolidated state than at present, they might be charged with water containing carbonic acid gas. This would act as a solvent of the organic atom of lime until the acid was neutralised." .

After venturing upon these conclusions in 1847, not as mere speculative guesses, but as the deliberate result of a long series of investigations carefully worked out, I need scarcely say how intense was the interest with which I read Dr. Wyville Thomson's observations, which so thoroughly sustain and confirm the accuracy of mine. My conclusions were wholly derived from the microscopic observations of earths and rock specimens which I compared with the few examples of foraminiferous ooze with which I was then familiar. The *Challenger* researches now show us how extensively the conditions described in my memoir have prevailed; a fact which could not have been ascertained before the machinery for deep-sea exploration attained to its present perfection. But having arrived at them in a decided or definite manner when the materials for doing so were much more scanty than they now are, and when no one except myself and the late Prof. Bailey of West Point were giving much attention to the subject, I think I am justified in wishing the fact to be placed on record.

Owens College, Dec. 12 W. C. WILLIAMSON

Origin of Bright Colouring in Animals

THE origin of the bright colouring of flowers, through natural selection effected by insects, appears to me one of the strongest points of the Darwinian theory. But I think the origin of the bright colouring of many animals, especially birds and insects, is on the contrary one of the greatest of its difficulties. Darwin accounts for it in most cases by sexual selection—the most beautiful males being the best able to obtain mates and to leave offspring.

In the way of this theory there are three very serious difficulties, which I think have not been dwelt on as they deserve.

1. Before special coloration could arise as a specific character, the colours must have been variable; for selection can work only when it has variation to work with, and it appears incredible that such a cause as sexual selection could ever give them any great degree of fixity. But the bars and spots on the wings of birds and butterflies are, as a rule, perfectly definite, and not more variable within the limits of the same species than any other part of the organism. This difficulty does not apply in the same degree to the origin of the coloration of flowers through

natural selection by insects, because the spots and streaks of flowers are much less sharply defined.

2. Why is ornamental colouring, as a rule, confined to the male? If the love of beauty is an animal instinct, why, on Darwinian principles, is not beauty developed in the females, the most beautiful females being the most likely to obtain mates and leave offspring? I speak chiefly of birds.

3. Is there any reason to believe that the female has any choice or power of selection whatever? I think that what evidence we have goes to prove that she is passive: and certainly this opinion is supported by the very general fact of the males fighting for the possession of the females.

If the love of beauty is an animal instinct, then Darwinian principles would require that the struggles of the males for the possession of the most beautiful females should develop beauty in the females by natural selection. But we see that the contrary is what takes place—beauty is developed in the male, the fighting sex.

Were a Darwin among birds to watch the ways of the human race, he would probably feel certain that the love of dress and ornament among women is altogether due to a desire to become attractive to men; and he would think those naturalists unsatisfactory, and perhaps mystical, who guessed the truth, that the love of ornament is a natural and healthy human instinct, not confined to either sex or to any age, but stronger in youth than in age, and stronger in woman than in man.

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim

Psychology of Cruelty

THERE is a passage in Mill's recently published essay on "Nature" which well merits the attention of evolutionary psychologists. It is as follows:—"Again, there are persons who are cruel by character, or, as the phrase is, naturally cruel; who have a real pleasure in inflicting, or seeing the infliction of pain. This kind of cruelty is not mere hardheartedness, or absence of pity or remorse; it is a positive thing; a particular kind of voluptuous excitement. The East, and Southern Europe, have afforded, and probably still afford, abundant examples of this odious propensity." (Page 57.)

Now, I think that this "hateful propensity" is of more common occurrence than even Mr. Mill here gives it credit for. Indeed, I doubt whether anyone is entirely devoid of it, although, of course, everyone who is sufficiently advanced in moral culture to admit of the subordination of the baser instincts to the higher, has been more or less successful in "starving it by disuse." I believe, in short, that this propensity must be regarded as one of the primary instincts of our nature, although, like other instincts, it varies in its original intensity in different individuals, and is further differentially modified by the various influences of education. The nature of this instinct is well expressed by Mr. Mill in the above-quoted phrase, "a particular kind of voluptuous excitement." This, I think, supplies the reason why it is, as a rule, of stronger development in men than in women, and why, as Mill observes, it is of most frequent manifestation in warm climates. It is also worth observing, that although thus akin to the amatory passion, it is of much earlier growth in the life-history of the individual. Indeed, childhood and youth are, in civilised society at least, the seasons when its presence is most conspicuous; in consequence, I suppose, of the restraining power which reflection subsequently brings to bear upon it not as yet having been called into action.

To explain the origin of this instinct by the evolutionary psychology is, I believe, impossible in the present state of our knowledge; for there is no period in the history of the race at which it is conceivable that the latter should have derived any benefit from the birth and development of this peculiar passion. Yet I believe it is now in some persons, were it permitted to assert itself, of even more intensity than is the highly beneficial inclination to which, as we have just seen, it is so strangely allied. To refer to the striking similarity of this passion in man to that which is manifested by monkeys, is not of course to explain its origin; but I am quite sure it is in the monkeys that this explanation is to be sought. Everyone knows that these animals show the keenest delight in torturing others simply for torturing sake, but everyone does not know how much trouble an average monkey will put himself to in order that he may gratify this taste. One example will suffice. A naturalist who had lived a long time in India told me that he has not unfrequently seen monkeys feigning death for an hour or two at a time, for the express purpose of inducing crows, and other carnivorous birds, to approach within grasping distance; and when one of the latter were caught, the delighted monkey put it to all kinds of agonies, of which plucking alive seemed to be the favourite.

As I am not aware that any other animal exhibits this instinct of inflicting pain for its own sake—the case of the cat with a mouse belonging, I think, to another category—I believe, if its origin is ever to receive a scientific explanation, this will be found in something connected with monkey-life.

PHYSICUS

Migration of Birds

YESTERDAY and to-day (17th and 18th inst.) continuous flights of migrant birds, chiefly fieldfares and redwings, have passed over this place in one uniform direction, from east to west, turning inland to the north-west, as though unwilling to cross Poole Harbour. The procession, so far as it attracted my own notice, began with daybreak of the 17th, and was so rapid and continuous all that day that enormous numbers altogether must have passed over us. Close flocks would come, and then a continuous flight of stragglers, but all in one and the same direction, and with little deviation from a well-defined aërial pathway, as though keeping some visible high-road. Yesterday the flight was down the wind; this morning against it; and although the flight was low and the birds seemed tired, none alighted in this neighbourhood. Whence did they come, and whither are they bound—east or west of this place? Can any of your readers say?

H. C.

Bournemouth, Dec. 18

The Potato Disease

IN his letter of last week, Prof. Dyer states that his main object in his previous letter was "to claim for a distinguished English botanist credit for work done by him thirty years ago." In his previous letter this work is defined by Prof. Dyer to be the discovery by the Rev. M. J. Berkeley of the fact that the potato disease was due to the attacks of a parasitic fungus. As the service, with which botanists are familiar, that Mr. Berkeley has rendered in this matter, is the publication and advocacy in this country of the discovery previously made by Montague and others, with a few additional observations of his own, Prof. Dyer would confer a favour on his fellow-botanists by giving a more exact reference to the records which he is so anxious should be duly recognised.

INQUIRER

*HELMHOLTZ ON THE USE AND ABUSE OF THE DEDUCTIVE METHOD IN PHYSICAL SCIENCE**

SINCE the translation of the first part of this volume was published, its whole scientific tendency, and specially a series of individual passages in it, have been subjected to a more than vigorous criticism by Mr. J. C. F. Zöllner in his book "On the Nature of Comets." I do not think it necessary to answer expressions of feeling in reference to personal characteristics of the English authors or of myself. I have as a rule considered it necessary to reply to criticisms of scientific propositions and principles only when new facts were to be brought forward or misunderstandings to be cleared up, in the expectation that, when all data have been given, those familiar with the science will ultimately see how to form a judgment even without the discursive pleadings and sophistical arts of the contending parties. If the present treatise were intended only for fully educated men of science, Zöllner's attack might have been left unanswered. It is, however, essentially designed for students also, and as junior readers might perhaps be misled by the extreme assurance and the tone of moral indignation in which our critic thinks himself justified in expressing his opinions, I consider that it would be useful to answer the attacks made on the two English authors, so far as may

* Translated by Prof. Crum Brown from Helmholtz's preface to the second part of the German edition of Thomson and Tait's "Natural Philosophy," vol. i.

be necessary to enable the reader to make out the truth by considering the matter for himself.

Among the scientific investigators who have especially directed their efforts towards the purification of physical science from all metaphysical infection and from all arbitrary hypotheses, and, on the contrary, have striven to make it more and more a simple and faithful expression of the laws of the facts, Sir W. Thomson occupies one of the first places, and he has consciously made precisely this his aim from the beginning of his scientific career. This very thing seems to me to be one of the chief services rendered by the present book, while in Mr. Zöllner's eyes it forms its fundamental defect. The latter would like to see, instead of the "inductive" method of the scientific investigator, a predominantly "deductive" method introduced. We have all hitherto employed the inductive process to discover new laws, or, as the case may be, hypotheses; the deductive to develop their consequences for the purpose of their verification. I do not find in Mr. Zöllner's book a distinct declaration by which his new mode of procedure may be distinguished from that generally followed. Judging from what he aims at as his ultimate object, it comes to the same thing as Schopenhauer's Metaphysics. The stars are to love and hate one another, feel pleasure and displeasure, and to try to move in a way corresponding to these feelings. Indeed, in blurred imitation of the principle of Least Action (pp. 326, 327), Schopenhauer's Pessimism, which declares this world to be indeed the best of possible worlds, but worse than none at all, is formulated as an ostensibly generally applicable principle of the smallest amount of discomfort, and this is proclaimed as the highest law of the world, living as well as lifeless.

Now, that a man who mentally treads such paths should recognise in the method of Thomson and Tait's book the exact opposite of the right way, or of that which he himself considers such, is natural; that he should seek the ground of the contradiction, not where it is really to be found, but in all conceivable personal weaknesses of his opponents, is quite in keeping with the intolerant manner in which the adherents of metaphysical articles of faith are wont to treat their opponents, in order to conceal from themselves and from the world the weakness of their own position. Mr. Zöllner is convinced "that the majority of the present representatives of the exact sciences are wanting in a clearly conceived intelligence of the first principles of the theory of perception" (p. viii.) This he tries to confirm by reference to supposed gross errors made by several of them.

Here then, of course, Messrs. Thomson and Tait must submit to the ordeal. They have, in paragraphs 381-385 of the present book given expression to their conviction as to the right use of scientific hypotheses. They, in paragraph 385, find fault with hypotheses which are too remote from observable facts, and select, as instances of their injurious influence, naturally only such as, by their extensive diffusion and by the authority of their originators, have been really influential. In this connection they place side by side the law of electrical action at a distance propounded by our countryman, W. Weber, and the emission theory of light as worked out by Newton. This juxtaposition is the best proof that the English authors had nothing in view that should wound a healthy German national feeling.

It has not as yet, I believe, come to such a pass in Germany—it is to be hoped it never will—that hypotheses may not be criticised, whatever be the eminence of their propounders. Should it actually ever come to this, then indeed Mr. Zöllner and his metaphysical friends would be justified in bewailing, or it may be in triumphing over, the destruction of German science. No one can be blamed for having advanced a hypothesis which the further progress of science shows to be inadmissible, just as it is no discredit for one who has to seek his way in an entirely unknown country to take the wrong road for once, in spite of his utmost attention and consideration. It is further obvious that whoever regards as erroneous a hypothesis which has captivated the minds of a large number of scientific men must necessarily hold that it, for the time being, injures and retards the progress of science, and will be justified in expressing this opinion, if it becomes his duty to advise, according to his matured conviction, a student as to the path he should follow.

One of the arguments which Sir W. Thomson has adduced to prove the inadmissibility of Weber's hypothesis, is that it contradicts the law of the conservation of energy. I was also obliged to bring forward the same allegation somewhat later in a paper * published in the year 1870. Now Mr. Zöllner, relying on the authority of Mr. C. Neumann, has assumed that this allegation is erroneous. On the contrary, Weber's law seems to him to be another universal law of all forces in nature (it is not explained how these different universal laws agree with one another), and he devotes twenty pages of his introduction to the purpose of airing his indignation at the intellectual and moral dulness of those who attack it. Mr. Zöllner will, no doubt, since then, have become aware that it is at least imprudent, without other support than the authority of one of the parties in a scientific debate, to try to help the other by libellous remarks, apart from the consideration that by such means one can contribute nothing to the settlement of the dispute, but perhaps much to its embitterment. Mr. C. Neumann was himself a party in this affair; my objections applied also to the theory of electrodynamic actions, to which he then adhered. He has since then given up this theory. He and also Mr. W. Weber thought that they could maintain the original theory of the latter, if they took into consideration the co-operative action of molecular forces in the case of closely approximated electrical masses. I then, in my second contribution to the theory of electrodynamics,† pointed out that the assumption of molecular forces does not stop the leak in Weber's theory. In the meantime Mr. C. Neumann himself, before he knew of my second paper, had given up the attempt to found a theory of electrodynamics upon Weber's law, and had tried to devise a new law for that purpose.

And here, in reference to the emphatic way in which our opponent speaks of the deductive method, I would make the following remarks on this example:—According to the view hitherto held by the best scientific investigators, the deductive method was not only justified, but indeed *required*, when the admissibility of a hypothesis was to be tested. Every legitimate hypothesis is an attempt to establish a new and more general law which shall include under it more facts than those hitherto observed. The testing of it consists in this, that we seek to develop *all* the consequences which flow from it, in particular those which can be compared with observable facts. I should therefore imagine the first duty of those who would support Weber's hypothesis to be, among other things, to see whether this hypothesis can explain the most general fact, that electricity, when no electromotive forces act on it, remains at rest in all electrical conductors, and is therefore capable of continuing in stable equilibrium. If Weber's hypothesis implies the contrary of this, as I have attempted to prove, then the next thing to be done would be to look out for such a modification of it as would render stable equilibrium possible in the largest as well as in the smallest conductors. According to my view, this would have been a right course, and the one required by the deductive method, but not to call a halt when inconvenient consequences appear, and excuse oneself with the plea that the right differential equations for the motion of

* "Ueber die Bewegungsgleichungen der Elektricität für ruhende leitende Körper." Borchardt, *Journal für Mathematik*, Bd. 72, 75.
† Borchardt, *Journal für Mathematik*, Bd. 75.

electricity in accordance with Weber's law had not yet been discovered. And if some one else takes this trouble, then he who considers himself a representative κατ' ἐξοχήν of the deductive method should applaud him, instead of charging him with impiety, even if the results of the inquiry should turn out to be inconvenient for the Icarus flight of speculation.

As Mr. Zöllner does not put himself forward as a mathematician—on the contrary, informs us on pages 426 and 427 of his book that the too frequent use of mathematics cramps the conscious activity of the understanding and is a convenient means of satisfying vanity; and besides, in many passages, constantly repeats his expression of contempt for those who think they can refute his speculations by pointing out mistakes in differentiation and integration—we ought not to judge him too severely in the matter of Weber's law. No doubt it is scarcely reasonable for one who thinks himself entitled to be shaky in his mathematics, to take upon himself to pronounce upon matters which can be decided by mathematical investigation only. His "Theory of Comets," which may surely be regarded as in his opinion a model specimen of how the right methods are to be employed, gives, besides this, other much more popular examples of the same peculiar way of using or not using deduction, examples the consideration of which may be reserved for another more suitable opportunity.

(*To be continued.*)

MOVEMENTS OF THE HERRING

THE mysterious disappearance of the body of herring which used to frequent Loch Fyne has directed renewed attention to the natural history of that fish. This is now the second time that the shoal of herrings which made Loch Fyne its *habitat* has deserted that celebrated sheet of water. No scientific opinion has yet been given as to the cause of this disappearance. A number of fishermen, resident on the Loch, say the herrings have been frightened away in consequence of persons fishing for them with a trawl net—which is, of course, nonsense; but not more nonsensical than the reasons assigned for the desertion by herring of other localities. As the so-called trawl-fishing of Loch Fyne (the net used is in reality a seine) was not in existence when the fish forsook the Loch on a former occasion, and were absent for a period of six years, the opinion of these men may be passed over as unworthy of serious consideration. Writers in the local newspapers, while inclined to favour the opinions of the drift-net men, that is, those who assert that the trawl-fishers have scared away the fish, also ask whether the spawning-beds may not have been in some way interfered with, and whether the body of fish frequenting the Loch may not from some unknown cause have departed before depositing their seed. If so, in what year would that occur? In other words, how long is it before the herring spawn of any given year comes to life, and at what period will the fish then born become reproductive?

These are events in the natural history of the herring, the dates of which have not yet been authoritatively settled. They are points, indeed, which have not yet been decided as regards any of our fish, except, *perhaps*, the salmon (*Salmo salar*), which has been nursed into life under a system that may be called artificial, that admitted of the young fish being watched, and their growth traced stage by stage, by means of certain signs and marks. It is thought that we may speak of the natural history of the salmon with more confidence than that of any of our other food-fishes. It is unfortunate that their studies of the natural history of the herring have not yet enabled naturalists to determine with exactitude how long it takes that fish to come to maturity.

Most varied opinions have been given on these points of herring life. Some persons have even gone the length of asserting that *Clupea harengus* and its congener *Clupea pilchardus* are able to perpetuate their kind within a year of their birth; even at the age of ten months! It has also been asserted that a herring is able to breed twice a year. Other opinions have been given, which assign to the herring a much longer period of growth, namely, that it requires from three to five years to reach maturity. Yarrell, again, and also Mitchell, think that it becomes reproductive in so short a period as eighteen months. What we may hold that we really do know is, that the eggs of the herring can be hatched within twenty days after their contact with the milt of the male fish. This has been proved by visiting the spawning places of the animals. On one visit all was spawn, everything that came in contact with the spawning-beds being covered with the seed of the herring; at the next visit, a fortnight after, the spawn was all gone; it had become vivified—and in proof of the fact, young herrings could in two or three weeks after be found in shallow places varying from an inch to two and even three inches in length. The probable time between the spawning of the fish and the fry reaching the dimensions named would be about forty days. How fast the young ones grow after that has not been authoritatively ascertained. It is thought, however, that if young herring reach the size of, say two-and-a-half inches, in forty days, it is not unreasonable to expect them to continue growing at the same ratio.

In the case of *Salmo salar*, the period necessary for the incubation of the egg has been determined beyond dispute. It ranges from 90 to 130 days. The growth of the young fish, after a time, if those who have watched it have not been deceived, is very rapid. At first, however, the salmon grows very slowly. A salmon hatched in March last may still be a very tiny animal, even after it is twelve months and in some cases two years old. In a year, however, it may be four or five inches long, and ready to migrate to the sea. There is a curious feature in the natural history of the salmon, the law of which has never yet been discovered—it is a riddle, in fact, even to the most scientific observers: only one half of the salmon of any particular hatching develop into what is called the *smolt*, or migratory stage, at the end of about twelve or fifteen months from the time of their being hatched. The other moiety of the brood does not seek the sea or take on the migratory dress till the expiry of a little over two years from the time of birth! One half of the fish, therefore, will at one and the same time be tiny creatures, about three inches long, whilst the other moiety will be five inches in length, and of corresponding girth; but these dimensions, it must be confessed, show no great rapidity of growth. Indeed, it is not till after the salmon proceeds to the sea that its growth becomes at all rapid; but, notwithstanding this rapidity, it must, we think, be a considerable number of years before a salmon can attain to the weight of fifty or sixty pounds; although the smolt, it is affirmed by those who have watched it, returns as a grilse to its native waters in about three months, its size and weight being very largely increased.

The herring, as we all know, is a fish that never attains to any great size, and the weight of which may be counted in ounces. The question to be answered is this: Do small fish grow to maturity quicker than large ones? It has been asserted, in some quarters, that the herring grows quite as rapidly as the smolt does *after* it reaches the salt water, and the rate of growth there appears magical, when contrasted with its slow progress during the first year of its existence, or it may be, as has been already explained, the first two years. We are not, however, without a certain kind of proof of the rate at which the herring grows, which is better than reasoning analogically. It is quite fair to conclude that if herrings attain a size of about three inches within forty days or so of their birth, they will attain their full dimensions within a year. It is known of herring, by means of personal observation, that from the time the roe or milt begins to develop itself, that is, when they become *maties*, no very long time elapses till they are ready to spawn: ten weeks has been estimated as about the time the herring takes to grow from a "matie," or fat fish, to a spawning herring.

The most contradictory accounts of the time at which herrings spawn have been published by various inquirers. Much of this confusion results, no doubt, from the fact that the herring is somewhere engaged in fulfilling this function of its life during nearly every month of the year. There are, it is thought, distinct races of this fish constantly coming to maturity and spawning at suitable times with the instinct of keeping up the breed. Thus, at Wick, on the Caithness coast, where there is still a great fishery carried on, although it is evidently now on the wane, herrings came to maturity and were ready to spawn in July. At one time large numbers of these (July) herrings were caught; indeed, some economists say too many were caught, and that in consequence the reproductive strength of the shoal was so impaired, or its economy so deranged, that it became exhausted. At any rate, few herrings are now taken in July at Wick. The great August shoal is being also over-fished, and symptoms are not wanting in the violent fluctuations which occur in the "takes," that it too will in time become unproductive. Herrings are found in the Firth of Forth ready to shed their spawn in the months of December, January, and February, and during these months young herrings and sprats (*Clupea sprattus*), are found mixed in the shoals which are fished at that period of the year. The question of where these schools of young fish go to whilst they are growing naturally presents itself. But who can answer it? The theory of the migration of the herring from and to the seas within the arctic circle has been long exploded, it having been established, it was thought, beyond cavil, that it is a native of our own seas: at all events, that it comes close to certain parts of the British sea-coasts to deposit its spawn. It is at that period of its life that we become familiar with the herring, and that is the time at which it can be most economically captured. Herrings are seen at that period of their lives in prodigious numbers; in fact, they lie in tiers on a favourite spawning ground, covering several square miles of sea-bottom. If all the parks of London were united together into one great space of ground, it would not nearly represent the width and length of a shoal of herrings engaged in spawning!

It has been asserted that herrings aggregate and segregate, but proof of this fact in their natural history is lacking. Almost immediately after the spawn has ripened into life, the tiny herrings are seen crowding together on the most shallow places of the coast, where they are safe from the attacks of larger fish, which would assuredly prey upon them if they frequented the deeper water. Now, if these fish separate, when do they do so? because, if they come to maturity, as is said, within a year, they have little time to live apart. If they go out to sea, how far do they go? It is a fact that at the time they are caught they are at first taken at a considerable distance from land. The writer has been out as far as twenty-five miles from the shore without finding a trace of the shoal; but within ten days or so the fish were found within a radius of ten miles of the port from which he had sailed in search of them, and they gradually came nearer and nearer, being often caught within two miles of the land. Although the fish of particular localities have such distinctive marks upon them as to render it easy to distinguish them, certain persons have again mooted the idea of the herring being a migratory animal, and that a great fish-shoal travels from the north to the south. A writer in a recent number of the *Scotsman* newspaper speaks of a vast shoal of herrings having arrived at Wick, then of its passing Fraserburgh and Peterhead; next, of its being found at Dunbar and Eyemouth; then on the coast of Northumberland; and finally, he tells us, it will be found at Yarmouth, on the coast of Norfolk! What else is this but a revival of a portion of the old myth? The shoal must be constantly finding out new places to visit, and must also be deserting places where it used to call; it must also tell off brigades to spawn at different localities; otherwise, all that we have learned about the natural history of the herring during the last few years is imaginary. Any novice, almost, could distinguish a herring taken from Loch Fyne, when placed side by side with a herring caught off the bay of Wick. Fraserburgh, one of the places cited by the writer in the *Scotsman*, has only risen to importance as a herring port within the last ten years; close upon seven hundred boats were this year engaged in the fishery, whilst in 1864 there was not much above a fourth of that number. At Fraserburgh, and two or three little fishing stations which adjoin it, 181,000 crans of herrings were captured this year, and these fish would be of the value of about 300,000*l.* The capture by the boats fishing from Peterhead—also on the Aberdeenshire coast—this season would not be of less value than a quarter of a million pounds sterling. But whilst these Aberdeenshire ports are rising into notice as great centres of the herring fishery, other ports are declining. Wick, which used to be the capital of herring fishery enterprise, is now on the decline as a curing station. Why? For the simple reason, it may be presumed, that the owners of boats do not find it profitable to fish at that port. At one time as many as 1,200 boats used to fish for the Wick curers, but the number at work this year was five hundred less! Such a falling off is very striking, and goes a long way to prove that it is possible to "over-fish" the herring, or at least so to derange the economy of the shoals as to render them in time unproductive. It is only reasonable to argue that with the largely augmented drifts of nets increased quantities of herring ought to be captured, but it is being annually demonstrated that such is not the case, and that to keep up present supplies and provide for the supply demanded by an exigent and increasing population, more boats and still more extensive drifts of nets are required.

Even very young fishermen have seen the rise and decline of important seats of the herring fishery, apparently from the over-fishing or derangement of the shoals. It will be instructive to note what occurs in future to the Wick fishery, because, only a few years ago, it was the greatest herring-curing station in the world, whilst next year there is every probability of its being only a fourth-rate fishing port. The fishermen will naturally go where they can take their prey with the least possible trouble, and where the fishery is more regular than it has been during late years at Wick, where most of the fish have been taken by a few of the more fortunate fishermen, and many of the boats had to return morning after morning "clean." The boats fishing at Fraserburgh this year took each an average of 220 crans of herrings, and all of them were tolerably well fished; whilst the Wick boats only averaged ninety-four crans, the fishing being even more partial than usual. The further development of the fishery at Fraserburgh, Aberdeen, and Peterhead, which extends over a space of about forty miles, will be anxiously watched. The shoal or shoals which are yielding such wealth to the fishermen of these ports must be prodigious in size and wonderfully productive; let us take note how long they last, and keep a correct tale of what they yield. The run upon them for the next two or three years will only be limited by the accommodation which the harbours can give to the boats and the ground which can be allotted to the curers. The movements of the herring become yearly more interesting, and we cannot be too well informed in regard to them.

THE TRANSIT OF VENUS

THE following telegrams have been received by the *Times* since our last issue.

"*Melbourne*, *Dec.* 11.—The American Expedition in Tasmania experienced unfavourable weather for their observations of the Transit of Venus."

"*Sydney*, *Dec.* 10.—The Transit observations here proved satisfactory."

"*Berlin*, *Dec* 17.—A telegram has been received from the German Astronomical Expedition at Tschifu, in North-eastern China, announcing that the observation of the Transit of Venus was quite successful. The observation of the contact, the heliometer measurement, and the photographs succeeded splendidly. The expedition was admirably supported by His Imperial Majesty's ship *Arcona*."

From Major Palmer, Christchurch, New Zealand :—

"English, nothing valuable anywhere—clouds. Americans got ingress, and photographs till near third contact. Nobody egress."

From Mr. Todd, Adelaide:—

"Transit of Venus.—Ingress cloudy. Egress well observed. Contacts 34434, 3475. (Probably 3h. 4m. 43·4s., and 34m. 7·5s. Adelaide mean time, for internal and external contacts.) No black drop."

From Vienna :—

"According to a telegram received by the Imperial Academy of Sciences from Drs. Weiss and Oppolzer, who went to observe the Transit of Venus at Jassy, the observation of external contact at the moment of the exit has succeeded. As they had time to fix the exact longitude and latitude of their point of observation, they obtained reliable data for calculation. The longitude was determined by telegraphic time signals with the Observatory in Vienna. As Jassy lies on the limits of the line where the phenomenon was visible, they attribute some importance to their observations."

Through Reuter's agency:—

"*Pekin*, *Dec.* 9.—The French astronomical party, under the direction of M. Fleuriais, succeeded in observing the first and second contacts. There was a slight black ligament. Photographs were taken. The weather was slightly hazy."

It will be seen that the news from New Zealand is of a most serious character, so far as the English scheme of observation is concerned. In fact, unless the French, Germans, and Americans have secured observations, the Delislean attack, so far as egress is concerned, has failed altogether. We shall postpone any further remarks till next week, as in the interval some information may be received from the stations to which we have referred.

NOTES

WE are informed that the Council of the Royal Society has appointed a Committee to consider the means of securing observations of the total eclipse of the sun in April next, to which they attach great importance.

PROF. CLERK-MAXWELL, F.R.S., has promised to give a lecture at the Chemical Society on Feb. 18 next, "On the Dynamical Evidence of the Molecular Constitution of Bodies."

THE *Times* states that Prof. Huxley is to undertake the duties of the Chair of Natural History in the University of Edinburgh during the ensuing summer session, in the absence of Prof. Wyville Thomson, who is with the *Challenger* Surveying Expedition.

THE Arctic Expedition Committee sits twice a week, and is making steady progress in organising preparations. The engines of the *Cygnet* gunboat, a new vessel, are to be removed and placed in the *Alert*, now in dock. Although not yet officially announced, we believe that the Admiralty have selected Commander Albert Markham as one of the commanding officers of the Arctic Expedition. Lieut. Aldrich, of the *Challenger*, is coming home with Capt. Nares to take part in the expedition. The decision recently made public that none but those of the Royal Navy would be permitted to take part in the expedition has been somewhat relaxed, and it is not improbable that some men of experience in whaling will be engaged as "ice quartermasters."

WE believe a few French naval officers desire to join the forthcoming English Polar Expedition, as Lieut. Bellot did on the occasion of one of the most interesting searches for Franklin. As is known, Bellot lost his life during the expedition, and the fact is commemorated by a column erected at Greenwich Hospital at the expense of the English Government.

LIEUT. CAMERON, in a despatch to Lord Derby, dated Ujiji, May 14, tells of an important discovery to which we briefly alluded last week in our report of the meeting of the Geographical Society. He has been all round the southern portion of Tanganyika, and believes he has discovered its outlet in a river named the Lukuga, a little to the south of Speke's Islands. He thinks also, from what he has heard from the Arabs, that the Lualaba is the Congo. The Lukuga he found to be obstructed with grass, but he believes a way might easily be cut through that. If Lieut. Cameron's conjectures turn out to be correct, and there appears to be great likelihood that they will, he will deserve to take an important place in the ranks of African explorers. He shows the great capabilities of Central Africa as a field for legitimate commerce, and if it turns out that navigation is possible from the mouth of the Congo to the Tanganyika region, much good may be expected to accrue to Africa as well as to the commercial world at large. The curse of the country is still those degraded Arab slave-dealers who vexed the soul of poor Livingstone, and it is a monstrous pity that some steps could not be taken to stamp out the demoralising and devastating traffic. Full details of Lieut. Cameron's explorations are in the hands of the Geographical Society.

THE last two parts of Petermann's *Mittheilungen* are naturally full of the Payer-Weyprecht expedition. The December number contains two letters from Lieut. Weyprecht, and one from Lieut. Payer, to Dr. Petermann. The former intimates that the amount of material collected in connection with the geography, meteorology, magnetism, &c., is immense; during the course of next year he will be preparing these for publication. He briefly states, as some of the conclusions he draws from the work of the expedition, that it is erroneous to conclude either that an open polar sea exists in the north, or that the ice on the south of Franz-Joseph's Land is impenetrable; that the drift of the ship in the ice was in no way owing to the Gulf Stream; and that he still adheres to the opinion that much valuable exploratory work can be done towards the east, with the Siberian coast as a basis of operations. Lieut. Payer believes that the nearest road to the pole is that by which the English Arctic Expedition is to go—Smith's Sound.

THE *Daily Telegraph* of Monday contains a long letter giving a very interesting account of Zanzibar, from Mr. H. M. Stanley, the leader of the expedition sent out by that paper in conjunction with the *New York Herald*. Another is to follow giving a description of the preparations for Stanley's long African march of discovery, and the detailed plans of route. This expedition is exceedingly creditable to the two papers, and it is a hopeful sign that a daily journal finds it answer to fill its columns with such healthy excitement.

A COMMUNICATION from her Majesty's ship *Scout* states that a monument has been erected on one of the islands of the Pacific to the memory of Captain Cook, who was killed by the natives of Owhyhee, ninety-five years ago. The monument is an obelisk 25 ft. high, and mounted on a base 8 ft. square. It is of concrete, and bears the following inscription:—"In memory of the great circumnavigator, Captain James Cook, R.N., who discovered these islands on the 18th of January, A.D. 1778, and fell near this spot on the 14th of February, A.D. 1779. This monument was erected in November, A.D. 1874, by some of his fellow-countrymen." It is erected on a suitable spot, about 100 yards from the rock on which the captain fell.

M. LEVERRIER, having finished with his tables of the Planet Neptune, will resume the duties of an active observer. For 1875 he will superintend personally the service of meridian observations at the Observatory of Paris, at the same time fulfilling all the duties of director of the establishment. M. Loewy will have the care of the special determinations of longitudes. These arrangements have been proposed by the Council of the Observatory to the Ministry, and will be no doubt approved of.

THE process of polishing the lens of the mirror of the great telescope is going on at the French National Observatory by M. Martin. The diameter of the lens is 120 centimetres, and the polisher is a disc of 40 centimetres. The number of men engaged on the polishing is six. They are obliged to stop frequently on account of the great weight of the polisher. An observer placed on the top of the Observatory, at a distance equal to half the focal distance, superintends the polishing process, watching if the image of a light which is placed in a proper position is reflected with sufficient exactness by the mirror below.

THE weather being very cold in Paris, and heavy falls of snow having taken place, M. Gaston Tissandier has taken advantage of the opportunity to make a series of most interesting observations on the dust which snow appropriates during its passage through the atmosphere. The results will be sent very shortly to the French Institute.

ON Thursday, December 17, at ten P.M., a magnificent falling star was observed in Paris. Its track was to be seen for more than a minute. A correspondent, Mr. J. H. A. Jenner, writing from Lewes, states that "on Thursday evening, the 17th inst., at 10.30, a very fine meteor was seen here. It travelled from north to south at a seemingly very low elevation, and though the moon was shining brightly, it was a very brilliant object, being several times the brightness of Sirius. Its colour was yellowish, and it left a long but not very persistent bluish-white train. Had the night been dark, it must have been a very splendid object. The point of disappearance was hidden from my sight by houses, but there was no noise attending it."

Two students of Girton College have been examined in the Cambridge Natural Science Tripos. Miss Kingsland, daughter of the Rev. N. Kingsland, Congregationalist minister, Bradford, passed equal to second class, and has been appointed assistant lecturer in Natural Science and Mathematics at Girton College. The other, Miss Dove, daughter of the Rev. J. Dove, vicar of Cowbit, Lincolnshire, would have been entitled to the ordinary degree, and has been appointed to an assistant mistress-ship at Cheltenham Ladies' College, with a special view to teaching physiology. These ladies passed the *vivâ voce* examination, and also in physiology and chemistry.

DR. J. G. M'KENDRICK recently commenced in Edinburgh a series of lectures to ladies on Physiology, at which we are pleased to hear there is an attendance already of seventy-one ladies.

THE Laurium mines in Greece have given rise to a new difficulty. not of a diplomatic, but of a botanical nature. Seeds which had been buried amidst the remains of old explorations for 2,000 ears, on being exposed to the air have undergone the usual process of germination, &c. These belong to the genus *glaucium*, but the species seems quite lost.

THE *Telegraphic Journal* for December 15 contains a figure and description of a most ingenious self-regulating electric lamp, by Siemens and Halske. This lamp is of very simple construction, and is stated to regulate itself with great accuracy. It is capable of being used either with a current of single direction or with the alternating current produced by certain magneto-electric machines.

WE have before us a Belgian Governmental publication in the *Bulletin de la Fédération des Sociétés d'Horticulture de Belgique*, for 1873. The volume contains biographies and portraits of eminent Belgian horticulturists recently deceased. A number of papers are printed in it, chiefly connected with Belgian horticulture; and it is supplemented by a list of all persons holding official botanical posts throughout the world.

LIEUT. CONDER, R.E., the officer in charge of the Palestine Survey Expedition, reports important discoveries of ruins in the hill country of Judah, which he proposes to identify with some of the lost Biblical cities and sites. He has been also engaged in a search for the limits of the Levitical towns, hoping to find some inscription or monument similar to that which rewarded M. Ganneau at the city of Gezer. He has not found any Hebrew inscriptions, but appears to have discovered boundary stones which may prove to be the ancient Levitical landmarks. Lieut. Conder promises to make a survey of Mr. Henry Maudsley's recent discoveries on Mount Zion for the Committee of the Palestine Exploration Fund.

THE report is to hand of Prof. Powell on the Survey of the Colorado of the West, dated Smithsonian Institution, Washington, D.C., April 30, 1874. This survey was placed under the direction of the Smithsonian Institution by Congress. The region embraced in the survey is one of the most interesting, in a geological point of view, in the world. The Colorado of the West and its tributaries traverse a series of remarkable chasms, in some instances of more than a mile in depth below the general surface of the region, presenting in several places, at one view, sections of the greater number of the known geological formations of America. In the report a general summary is given of the entire work. It exhibits a great amount of labour, and a series of results, not only of importance to science, but also to a knowledge of the country in its relations to agriculture and mineralogy. The report embraces a statement of what has been accomplished in the way of, first, Topography, as based on triangulation, including a description of the arable valleys, the supply of water, the extent of timber and of pasture land; second, Geology, including economic mineralogical products, such as coal, salt, and other minerals; third, Ethnology, comprising tribes, political organisation, languages, manners, customs, mythology, poetry, arts, &c.; fourth, Natural History, including mammals, birds, reptiles, insects, and plants.

SOME time since we intimated in NATURE that the enterprising Tyneside Naturalists' Field Club had resolved to catalogue all the remarkable trees in the extensive district which it works. The paragraph referred to has, we are glad to see, been the means of originating a similar enterprise in America. The New England Society of Orange, New Jersey, has issued the first of a series of publications, under the name of the "Babbit Portfolio," giving a history and description of the notable trees in its locality, accompanied by beautifully executed photo-engravings. The first number contains the "Valley Oak" (*Quercus albus*), the "Hillyer Elm" (*Ulmus americana*), and the "Harrison Buttonwood (*Platanus occidentalis*). Dr. Babbit, after whom the Portfolio is named, was the first to set out shade-trees in Orange.

PROF. BUCKLEY, State Geologist of Texas, has published a synopsis of the work done under his auspices during the past season, and remarks that fifty-four counties have been visited by himself and assistants. The results of his investigations show that Texas has vast deposits of iron and coal, of much greater extent than had been anticipated. Both are of excellent quality, and in some cases they occur near together. He has also found an abundance of salt, gypsum, and a wide range of copper ores. Other valuable minerals are roofing slate, marble, soapstone, &c.

THE Engineer Department of the United States Army has issued a "Catalogue of Plants collected in the years 1871, 1872, and 1873, with Descriptions of New Species." This is a portion of a series of publications brought out under the same auspices, being a report of geographical and geological explorations and surveys west of the 100th meridian, under the charge of First-lieutenant G. M. Wheeler.

WE are pleased to learn from the "Tenth Report of the Board for the Protection of the Aborigines in the Colony of Victoria," that the condition of the aborigines from the foundation of the colony was never so prosperous as at the present time. Very successful experiments at hop-growing have been made in some of the districts allotted to the natives, who take kindly to the light and comparatively well-paid work. The cultivation of hops will be extended to other districts. Considerable success has also been attained in the education of the children.

DR. JOHN DOWSON has sent us two pamphlets of which he is the author: "Thoughts, Philosophical and Medical, selected from the Works of Francis Bacon," and "A Sketch of the Life and Works of Erasmus Darwin, M.D., F.R.S." H. K. Lewis, Gower Street, is the publisher.

THE *Quarterly Journal* of the Meteorological Society, just issued, contains a number of papers read during the last session of the Society, abstracts of most of which have appeared in these pages.

THE "Proceedings of the Belfast Natural History and Philosophical Society" for 1872-3-4 have been published. Among the papers of scientific interest are the President's (Mr. J. J. Murphy's) addresses, "On Cosmological Science," and "On the present state of the Darwinian Controversy;" Prof. Everett "On Mirage," published in NATURE, vol. xi. p. 49; "On some New Methods of Chemical Analysis," by Prof. Hodges; "On the Solar Spots," by Mr. Murphy; "On Rainbow, Halos, and Coronæ," by Prof. Purser; "On Underground Temperature," by Prof. Everett; "On the Origin and Metamorphoses of Insects," by Mr. Murphy; "On the Composition of an Inflammable Gas issuing from below the Silt-bed in Belfast," by Dr. Andrews, F.R.S.

WE have received two reprints from the "Proceedings" of the Liverpool Geological Society, 1873-74: "The Metamorphic Rocks of the Malvern Range and the Strata derived from them," by Dr. C. Ricketts, F.G.S.; and "Tidal Action as a Geological Cause," by Mr. T. Mellard Reade, C.E., F.G.S.

IT is gratifying to see, from the Seventh Annual Report of the Eastbourne Natural History Society, that the Society is, on the whole, in a flourishing condition. It is doing very satisfactory work in the collection and arrangement of the fauna and flora of its district.

THE additions to the Zoological Society's Gardens during the past week include a Peregrine Falcon (*Falco peregrinus*), European, presented by Mr. A. F. Ross; a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, purchased; and eight Canadian Beavers (*Castor canadensis*) from North America, deposited.

THE ROYAL SOCIETY MEDALS

WE have already announced the names of those to whom the Royal Society Medals have been awarded; the following is the official account of the presentation by the Vice-President and Treasurer, Mr. Spottiswoode, at the Anniversary Meeting on the 30th ult.:—

The Copley Medal has been awarded to Prof. Louis Pasteur, one of our foreign members, "for his researches on Fermentation and on Pebrine."

Prof. Pasteur's researches on fermentation consist essentially of two parts: the first part, in which he enters exhaustively into the examination of the products formed in this process; and the second, in which he takes up the question of the cause of fermentation.

Previous observers had noticed the production, in solutions of sugar which had been fermented, of substances other than the two commonly recognised, alcohol and carbonic acid; but it remained for Pasteur to show which were essential and which were occasional products. In the series of able papers contributed to the *Comptes Rendus* and to the *Annales de Chimie et de Physique*, he proved conclusively that succinic acid and glycerine were always found in fermented solutions of sugar, while lactic acid and acetic acid, although occasionally present, were not always so. He also showed that, in addition to these substances, a part of the sugar was converted into cellulose and fat.

The study of the products formed during fermentation opened the way to the second part of the research, viz., the cause of fermentation.

It had been found that certain solutions, when exposed to the air, soon became full of living organisms; and Pasteur's experiments led him to support the view that these organisms originated from the presence of germs floating in the air. He found that no living organisms were developed if care were taken to destroy completely all those which might be present in the solution, and if the solutions were then carefully sealed up free from air. Nor was it necessary to exclude the air, provided that pure air, free from germs, were admitted. By passing the air through red-hot tubes or through gun-cotton before reaching the solutions, he found that the development of organisms, in such boiled solutions, did not take place. An exception to this was noticed in the case of milk, which required to be heated to a higher temperature than the boiling-point of water at atmospheric pressure. Pasteur showed that this was connected with the alkaline reaction of milk, for in all cases in which the development of life was prevented by heating to the boiling-point of water, the solutions had a faintly acid reaction—but that when this was neutralised by carbonate of lime, the solutions then behaved like milk.

Prof. Pasteur also examined the gun-cotton through which the air had been passed; and he found, among other things, certain cells to which he attributed the power of causing the growth of organisms in solutions. By sowing some of these cells in solutions which previously had remained clear, and finding that such solutions speedily became turbid from the growth of living organisms, it was proved that the air which had passed through the gun-cotton had lost its property of causing the development of life in solutions, because the germs which the air contained had been stopped by the gun-cotton.

The result of the second part of the research may be thus summed up:—

1. No organisms are developed in solutions if care be taken to prevent the possibility of the presence of germs.
2. This negative result does not depend upon the exclusion of oxygen.
3. The matter separated from ordinary air is competent to develop organisms in solutions which previously had remained unchanged.

Not less important were the results of Pasteur's experiments respecting the chemical functions of the ferment.

It had been held that the entire ferment was in a state of putrefactive decomposition, and induced a similar decomposition in the sugar with which it was in contact.

In corroboration of this view, it was stated that ammonia (a product of the decomposition of albuminous substances such as those present in the ferment) is always found in liquids which are undergoing fermentation.

Pasteur proved that the ammonia in fermenting liquids diminishes in quantity in proportion as the process advances, and that the yeast-cells increase and grow while forming complex albuminous substances at the expense of the ammonia and other aliments which are supplied to it. He found that, in addition to ammonia and sugar, the cells require mineral substances, such as phosphates and other constituents, such as are present in the organism of every healthy and growing yeast-cell.

In short, he proved that those conditions which are most favourable to the healthy growth and development of the yeast-cells are most conducive to the progress of fermentation, and that fermentation is impeded or arrested by those influences which check the growth or destroy the vitality of the cell.

The above results are but samples of the fruits of Pasteur's long series of researches in this subject. Many and many an able investigator had worked in the same field; and such were the difficulties they encountered, that Dumas himself recommended Pasteur not to waste his time in working at so hopeless a subject.

To the biologist, two of Pasteur's researches are of very great interest and importance. He has shown that *fungi* find all the materials needed for their nutrition and growth in water containing an ammonia salt and certain mineral constituents, and devoid of any nitrogenised organic matter; and he has proved that all the phenomena presented by the destructive silkworm epidemic, the *pebrine* (even the singular fact that it is hereditarily transmitted through the female, and not through the male), are to be explained by the presence of a parasitic organism in the diseased caterpillars.

The medal was received for Prof. Pasteur by the Foreign Secretary of the Society.

The Rumford Medal has been awarded to Mr. J. Norman Lockyer, F.R.S., "for his Spectroscopic Researches on the Sun and on the Chemical Elements."

Mr. Lockyer has long been engaged in spectroscopic researches on the sun. His first observations were directed to a scrutiny of the spectrum of sun-spots as compared with that of the general surface, with a view to bring evidence to decide between two rival theories respecting their formation. In the course of the paper in which his first observations were described, and which was read before the Royal Society on November 15th, 1866, he asks, "May not the spectroscope afford us evidence of the existence of the 'red flames' which total eclipses have revealed to us in the sun's atmosphere, although they escape all other modes of examination at other times?"

The spectroscope he then employed proved to be of insufficient dispersive power for his researches, and he was induced to apply to the Government-Grant Committee of the Royal Society for aid to construct one of greater power. This aid was accorded, and the instrument was delivered, though not quite complete, on the 16th of October, 1868. On the 20th his efforts were crowned by the detection of a solar prominence by means of the bright lines exhibited in his spectrum. An account of this discovery was immediately communicated to the Royal Society and to the French Academy of Sciences.

Meanwhile had occurred the total solar eclipse of August 18th, 1868, to observe which various parties had gone out armed with suitable instruments, and especially with spectroscopes, for determining the character of the hitherto unknown spectrum of the prominences; and the first-fruits of their labours had reached Europe, showing that the spectrum in question is one of bright lines. It occurred to M. Janssen, who had observed with eminent success the spectrum of the prominences during the eclipse, that the same mode of observation might enable one to detect them at any time, and he saw them in this manner the very next day. The first account of this discovery, which was sent by post, did not, however, reach the French Academy until a few days after the communication of Mr. Lockyer's notice; so that nothing interferes with the perfect independence with which these two physicists established the possibility of detecting the prominences at any time.

A discovery like this opened up a new field of research, which Mr. Lockyer was not backward in exploring. One of the first-fruits of the application of the method was the discovery of a continuous luminous gaseous envelope to the sun, which he calls the chromosphere, of which the prominences are merely local aggregations. Evidence was further obtained of gigantic convulsions at the surface of the sun, which were revealed by slight alterations of refrangibility in the lines, observed in a manner similar to that in which Mr. Huggins had determined the relative velocity of approach or recess of the Earth and Sirius.

The interpretation of spectroscopic solar phenomena required a re-examination in several respects of the spectroscopic features of artificial sources of light. Among these researches special mention must be made of Mr. Lockyer's classification of the lines due to the metals of the electrodes between which an induction discharge was passed, according to their "length," *i.e.*, the distance from the electrodes to which they could respectively be traced. This led to the explanation of various apparent anomalies as to the presence or absence of certain dark lines in the solar spectrum, and to the detection of additional elements in the sun, especially potassium, an element which, though so common on the earth and so easily detected by spectral analysis, had not previously been proved to exist in the sun, because the attention of observers had been turned in a wrong direction, as was shown by these researches.

Nor was it only in relation to solar physics that these researches bore fruit. They led to a *quantitative* determination in many cases, by means of the spectroscope, of the proportion of the constituents in an alloy, and afforded new evidence of the extent to which impurities are present even in substances deemed chemically pure.

The medal was received by Mr. Lockyer.

A Royal Medal has been awarded to Mr. Henry Clifton Sorby, F.R.S., "for his researches on slaty cleavage and on the minute structure of minerals and rocks; for the construction of the Micro-Spectroscope, and for his researches on colouring-matters."

The principal grounds on which Mr. Sorby's claims to a Royal Medal rest are the following:—

1. His long-continued study, and his successful application of the microscope to the solution of problems in petrology.

2. His employment of the prism in conjunction with the microscope for the analysis of the colours transmitted by substances, as well organic as inorganic.

Though Mr. Sorby's labours during the last ten years have been more particularly devoted to observations of the latter class, his work, extending over a period that commenced in 1849, is represented in the Catalogue of Scientific Papers (limited by the year 1863) by no less than forty-seven memoirs. Among the more remarkable of these must be mentioned the reports to the British Association and the contributions to the *Philosophical Magazine* (1853, 1856, 1857), in which he grappled with the subject of slaty cleavage, and helped to establish the explanation that cleavage was the result of greater relative condensation of the material in a direction perpendicular to the cleavage, due in the case of rocks to mechanical compression in that direction—an idea that met with immediate illustration from other experimentalists.

His memoirs on the temperatures and pressures at which certain rocks and minerals were formed (in the Geological Society's *Journal*, 1858), founded on the relative volume of the liquid and vacuous portions of microscopic hollows, or, again, on the character of microscopic substances mingled with the mineral matter he investigated, convinced the geologist that he had to take into account the action of water under high pressures and at high temperatures in explaining the formation of granitoid rocks. And the refinement of the methods that Mr. Sorby employed for making his rock-sections at Sheffield has made those methods the models sought after by the now large school of Continental and English microscopic petrologists.

His applications of spectroscopic methods to the microscope fall more strictly within the limit of ten years, as they have been worked out since 1867, when Mr. Sorby first described his adaptation of the spectroscope to the microscope, as carried out by Mr. Browning.

The observations he has made with this instrument, and generally by combining optical examination with the use of chemical reagents, have extended over a very wide range—such as the recognition of blood-stains, of adulteration in wine, the means of discriminating among the compounds of certain of the metals, chiefly of zirconium, titanium, and uranium, by the aid of blow-pipe beads—and finally to the elucidation, to a considerable extent, of the causes of the complexity in the tints exhibited by plants in the different stages of development of their annual foliage and flowers.

These are only some of the more important of Mr. Sorby's contributions to science; and they are characterised by an untiring application of the methods of experimental research to a great variety of subjects suggested by a very ingenious and active mind.

The medal was received by Mr. Sorby.

A Royal Medal has been awarded to Prof. William Crawford Williamson, F.R.S., "for his contributions to Zoology and Palæontology, and especially for his investigation into the structure of the fossil plants of the coal-measures."

Prof. Williamson's contributions to biological science were commenced forty years ago, and embrace investigations into the structure of the Foraminifera, the Rotifera, the scales and bones of fishes, and the fossil plants of the Carboniferous and Oolitic periods. These comprise works of great merit and value, not only on account of their accuracy and the extent and novelty of the observations which they contain, but by reason of the breadth of view and the philosophical spirit which pervade them.

His labours in Vegetable Palæontology are above all remarkable, being alike laborious, searching, and productive of important results. These are embodied in six contributions (of which the last will soon appear) to the Philosophical Transactions upon the organisation of the fossil plants of the coal-measures—and one on the restoration of a Cycadeous tree (*Zamia gigas*) from the Yorkshire Oolite, published in the Transactions of the Linnean Society. These are not only models of laborious research and exact description, but they are illustrated by more than fifty plates, devoted to microscopic analyses of vegetable tissues, obtained by making transparent slices of the fossils. Both the slices and the drawings are made by Prof. Williamson himself, who thus, to his reputation as a biologist, unites those of an accomplished artist and a skilful lapidary, qualifications which should be named along with those for which the medal is awarded, because no unscientific lapidary could have obtained equally illustrative sections, and no common artist could have depicted them with equal exactitude. The more important results thus obtained refer to the structure, affinities, and reproductive organs of Calamites and its allies, to Lepidodendron, Sigillaria, Lepidostrobus, Asterophyllites, and to other genera of the Carboniferous epoch.

In addition to these contributions to the history of previously known genera of that epoch, Prof. Williamson has been able to show, on the one hand, that groups of now living plants which were not previously supposed to have a great geological antiquity, actually flourished during the Carboniferous period, and, on the other, that plants of that period which had been previously referred with confidence to groups now living, have in reality other and widely different affinities.

The medal was received by Prof. Williamson.

SCIENTIFIC SERIALS

Astronomische Nachrichten, No. 2014.—In this number appear some interesting observations made by Nicolaus V. Konkoly on the spectrum of meteorites. Some 130 of the August meteors were examined, and it was observed that the nucleus gave a continuous spectrum, the apparent colour of the naked eye predominating in the spectrum. The tail of the yellow meteors gave the sodium lines only, the green one gave magnesium lines, and the red ones strontium or lithium. The sodium lines were present in all. In some of the larger meteors the author suspects the spectrum of iron is present.—Position observations of Coggia's comet are given by Argelander and by Tebbutt, of the Windsor Observatory, N.S. Wales.—Dr. Kleim writes objecting to the explanation of variation of brightness of Jupiter's moons during transit, given by Herr S. Alexander.—Dr. Luther gives position observations of Peitho (118) and elements of Danäe (61).—The elements of Borrelly's comet are given by Grützmacher, and those of Sylvia by Tietjen.—F. Anderson sends an opposition ephemeris of the planet Undina for November and December.—Prof. Spoerer gives observations of sun-spots and protuberances; and observations of the occultation of Venus by the moon, taken at Kiel, are given.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie.—Dec. 1.—In an article on the non-periodic movements of the barometer and the baric windrose, Dr. Köppen, taking into consideration the almost constant cyclonic movement of the air in Europe, asks how it is, while gradients are steepest with west and south-west winds, that when the barometer is observed at equal distances round a minimum centre, it is not found to be highest where the south-west wind is blowing. The mean height of the barometer is on the contrary considerably higher with north and east winds. The explanation lies in the difference between northern and southern Europe with respect to the magnitude of non-periodic oscillations of the barometer. —The low pressure in the north and north-west during the prevalence of south-west winds is not compensated by an adequately high pressure in the south and south-east. Air flows thence either to form a maximum over a small space in high latitudes, or southwards over a large space without causing high pressures. Similarly, but conversely, with north and east winds. —Among the "Kleinere Mittheilungen" we have a notice of Prof. Dove's article on cool Mays after mild Januarys, published in the magazine of the Berlin Academy. Herr Dove regards as proved a tendency to low temperatures in spring after warm winters. It appears that a mild January is generally followed in the interior of continents by a mild May, on the north and east coasts by a cool May, on the Atlantic Ocean again by a May milder than usual.

SOCIETIES AND ACADEMIES

London

Royal Society, Dec. 10.—"On the Development of the Teeth of the Newt, the Frog, and certain Lizards, and on the Structure and Development of the Teeth of Ophidia." By Charles J. Tomes, M.A.

The descriptions given by Arnold and Goodsir of the development of the human teeth have been already demonstrated to be in material respects inaccurate as applied to man and other Mammalia; and the present paper shows that the accounts propounded by Prof. Owen, of the process in Batrachia and Reptilia, which are practically an extension of the theories of Goodsir to these classes, are even more at variance with the facts of the case.

There is in no Batrachian or Reptile any open groove or fissure ("primitive dental groove"); there are, at no period of development, free papillæ; consequently the whole process of "encapsulation" has not any existence, but is purely hypothetical. From first to last the whole process of tooth-development takes place in solid tissue, beneath an even and unbroken surface; with which, however, the young tooth sacs have a connection through a band of epithelial cells. The first process is a dipping down of a narrow process of the oral epithelium, the extremity of which, after it has penetrated in some, as the snake, to a great depth, becomes dilated, and is transformed into the enamel organ; and this is the case whether a recognisable coat of enamel is or is not to be found on the perfect tooth. Subsequently to the dipping in of the band of epithelium, and concomitantly with the dilatation of its end, a dentine pulp is formed opposite to it. This may constitute the entire tooth sac, which is then wholly cellular, as in the newt; or it may go on further to the formation of a connective-tissue tooth capsule. The external thin structureless coating of the teeth of Ophidia is derived from an unmistakeable enamel organ, developed as above described; it is therefore enamel, and not cementum, as it is denominated by Prof. Owen. The successional tooth sacs, very numerous in the snakes, are located in a sort of capsule: this character, peculiar to the Ophidia, and most marked in the lower jaw, is of obvious service during the extreme dilatation which the mouth undergoes, as is also the tortuosity of the process of epithelium, before it reaches the collection of tooth sacs. The epithelial band may be traced winding by the side of the older tooth sacs till it reaches the position of the youngest, where it ends in a cæcal extremity, to be transformed into the enamel organ next developed. In fine, the stages of open groove, free papillæ, and encapsulation of the same have no existence whatever in Batrachia and Reptilia, their existence having been previously disproved in Mammalia.

"Experiments showing the Paramagnetic condition of Arteria Blood, as compared with the Diamagnetic condition of Venous Blood." By Richard C. Shettle, M.D.

The experiments consist in suspending between the poles of a powerful electro-magnet arterial blood, hermetically sealed in a glass tube, in a medium of venous blood, and venous blood in the same tube, previously well emptied of its contents, in a medium of arterial blood, care being taken to avoid as far as possible any exposure of the blood to the atmosphere; thus preventing any alteration in its physical characteristics as regards the gases which it contains.

In the former of the two cases the testing tube was found to take an axial, and in the latter an equatorial position.

Dec. 17.—"Note on the Vertical Distribution of Temperature in the Ocean." By J. Y. Buchanan, chemist on board H.M.S. *Challenger*. Communicated by Prof. A. W. Williamson, For. Sec. R.S.

From newspapers and other reports which have been received by late mails, it appears that the distribution of temperature in the ocean is occupying the attention of a certain portion of the scientific public, and even giving rise to considerable discussion. The observations made on board this ship, and more especially in the Atlantic, have furnished the greater part of the material on which the various speculations have been founded. It appears to me that one point suggested by these observations has not received sufficient attention from those who have written and spoken on the subject—I mean the effect of the changing seasons on sea-water. Consider the state of the water at and near the surface of the ocean, somewhere not in the tropics. To be more precise, let us suppose that we have taken up our position in the middle of the North Atlantic, somewhere about the 30th parallel. This part of the ocean is not vexed with currents, and affords the best possible field for the observation of the phenomenon in question. The whole ocean, enclosed by the 20th and 40th parallels of north latitude, and the meridians of 30° and 60° west longitude, forms one oceanic lake, not affected by the perturbing influence of currents or of land; and where, therefore, the true effect of differences of atmospheric temperature on the waters of the ocean may be most advantageously studied. Let us assume the winter temperature of the surface-water to be 60° F. and the summer temperature to be 70° F. If we start from midwinter, we find that, as summer approaches, the surface water must get gradually warmer, and that the temperature of the layers below the surface must decrease at a very rapid rate, until the stratum of winter temperature, or 60° F., is reached; in the language of the isothermal charts, the isothermal line for degrees between 70° F. (if we suppose that we have arrived at midsummer) and 60° F. open out or increase their distance from each other as the depth increases. Let us now consider the conditions after the summer heat has begun to waver. During the whole period of heating, the water, from its increasing temperature, has been always becoming lighter, so that heat communication by convection with the water below has been entirely suspended during the whole period. The heating of the surface water has, however, had another effect, besides increasing its volume; it has, by evaporation, rendered it denser than it was before, at the same temperature. Keeping in view this double effect of the summer heat upon the surface water, let us consider the effect of the winter cold upon it. The superficial water having assumed the atmospheric temperature of, say, 60° F., will sink through the warmer water below it, until it reaches the stratum of water having the same temperature as itself. Arrived here, however, although it has the same temperature as the surrounding water, the two are no longer in equilibrium, for the water which has come from the surface has a greater density than that below at the same temperature. It will therefore not be arrested at the stratum of the same temperature, as would have been the case with fresh water, but it will continue to sink, carrying of course its higher temperature with it, and distributing it among the lower layers of colder water. At the end of the winter, therefore, and just before the summer heating recommences, we shall have at the surface a more or less thick stratum of water, having a nearly uniform temperature of 60° F., and below this the temperature decreasing at a considerable, but less rapid rate, than at the termination of the summer heating. If we distinguish between *surface water*, the temperature of which rises with the atmospheric temperature, following thus, in direction at least, the variation of the seasons, and *sub-surface* water, or the stratum immediately below it, we have for the latter the (at first sight) paradoxical effect of summer cooling and winter heating. The effect of this agency is to diffuse the same heat to a greater depth in the ocean, the greater the yearly range of atmospheric temperature at the surface. This effect is well shown in the chart of isothermals, on a vertical section between Madeira and a position in lat. 3° 8′ N., long. 14° 49′ W. The isothermal line for 45° F. rises from a depth of 740 fathoms at Madeira, to 240 fathoms at the above-mentioned position.* In equatorial regions there is hardly any variation in the surface-temperature of the sea; consequently, we find cold water very close to the surface all along the line. On referring to the temperature section between the position lat. 3° 8′ N., long. 14° 49′ W., and St. Paul's rocks, it will be seen that, with a surface-temperature of from 75° F. to 79° F., water at 55° F. is reached at distances of less than 100 fathoms from the surface. Midway between the Azores and Bermuda, with a surface-temperature of 70° F., it is only at a depth of 400 fathoms that we reach water of 55° F.

* There will, I think, be no violence in assuming an acquaintance with these charts, at least among the scientific public, as they have lately formed the subject of lectures by Dr. Carpenter, and will no doubt have been published before this reaches England.

The above theory of vertical diffusion of temperature in the ocean, owing to convection brought about by the yearly range of temperature at the surface, presupposes that (at least in regions where the range is considerable, and where the great vertical diffusion of heat in question is oberved) the slightly concentrated water, descending from the surface as the winter approaches, does not meet water of greater density at the same temperature than its own. Unfortunately the determination of the specific gravity of water below the surface is much less simple than that of the temperature. For although we have an instrument which gives, within any required degree of accuracy, the density of the water at any depth in exactly the same way as the thermometer gives its temperature, the results of the observations are composed of three factors, which depend on the temperature, the pressure, and the *salinity*. By sending down a thermometer along with it we might clear the result for temperature; by noting the depth we might clear for pressure; but the result so cleared would not represent the salinity of the water at the depth in question, but the average excess of salinity of the column of water above it, over or under the mean salinity assumed for sea-water, in the calculation of the pressure exercised by a column of it. There remains, therefore, nothing for it but to fetch a sample of water from each depth, and determine its specific gravity on board. As this is an operation which takes up some time, the number of "serial specific gravity" determinations is comparatively small.

The following are the results of two which were obtained on the voyage between Bermuda and the Azores. The results show the specific gravity at 60° F., that of water at 39°·2 F. being taken as unity.

I. was taken on June 18, 1873, in lat. 35° 7′ N., long 52° 32′ W.

II. was taken on June 24, 1873, in lat. 38° 3′ N., long. 39° 19′ W.

For comparison I give one equatorial and one South Atlantic "serial specific gravity" determination.

III. was taken on Aug. 21, 1873, in lat. 3° 8′ N., long. 14° 49′ W.

IV. was taken on Oct. 3, 1873, in lat. 26° 15′ S., long. 32° 56′ W.

Depth in fathoms.	Specific gravity at 60° F. Distilled water at 39°·2° = 1.			
	I.	II.	III.	IV.
0	1·02712	1·02684	1·02591	1·02703
50	...	...	1·02658	1·02682
100	...	...	1·02643	1·02649
150	1·02701	1·02677	...	...
200	...	...	1·02620	1·02608
250	1·02683	1·02641	...	...
300	...	...	1·02610	1·02573
400	...	...	1·02629	1·02554
500	1·02604	1·02608	...	...

From the figures in the Table it will be seen that in that part of the ocean the specific gravity of the water in summer decreases from the surface downwards. As a rule it attains an inferior limit at a depth of from 400 to 500 fathoms, which it preserves to the bottom. In those latitudes, therefore, the stratum of intermixture extends down to 500 fathoms; and this may be said also to be the depth to which the sun's influence at the surface penetrates. The results in column III. show the curious phenomenon of the surface water being specifically lighter than any water below it, and that under an equatorial sun. The position of this sounding was peculiar, inasmuch as it was within line of separation between the Guinea and the equatorial currents. All along the equatorial section the water at 50 and 100 fathoms was found to be specifically heavier than either at the surface or that at greater depths. All along the equator, however, a current runs with great velocity; and I have invariably observed that strong surface-currents introduce considerable irregularities into the specific gravity of the water near the surface. The effect of the greater specific gravity at 100 fathoms conspires, of course, within the small yearly range of temperature, in preventing vertical diffusion in the above described manner. Column IV. shows a return, in the southern hemisphere, to a state of things similar to that which obtains in the North Atlantic.

We have seen that the effect of climate in equatorial regions is to render the sub-surface water much colder than it is in temperate regions; let us consider what would be the effect of a polar climate on the sea-water. It must be observed that the effect of the atmospheric temperature on the sea is determined by the temperature assumed by the surface-water; now the lowest temperature which surface-water can attain is its freezing-point. As the temperature of the air when the *Challenger* was beyond the 60th parallel was almost constantly below 32° F., freezing must go on to a very great extent in winter, and the effect of freezing such water is, in the end, similar to that of evaporating it; it is separated into lighter ice, and denser mother-liquor, which sinks, leaving ice on the surface. This ice I found to be a mixture; and on determining the melting-point of some in crystals, which had formed in a bucketful of sea-water, I found it began to melt at 29·5° F., the water produced by it being almost fresh, in comparison with sea-water. The lowest temperature of surface-water registered was 27° F.; this happened on two occasions, but was quite exceptional, the usual surface-temperature varying from 32° to 34° F. At this temperature a sensible quantity of ice would melt, giving very light surface water. On two occasions the specific gravity of the surface water was found between 1·02400 and 1·02410. The specific gravity increased rapidly up to a depth of 100 fathoms, when it remained pretty uniform to the bottom. Here, as at the equator, it is in winter that the sub-surface water perceives the effect of the change of season, the mother-liquor of the forming ice diffusing in its descent the temperature of its formation.

In the discussion of oceanic phenomena too much attention is usually paid to the great currents. When it is wished to study the phenomena due to temperature, or to any single cause, the effect of the winds, which is seen in its most intense form in the ocean currents, should be eliminated as far as possible; which in this case can only be done by selecting comparatively motionless seas, like the one which I have mentioned in the North Atlantic.* When the effect of atmospheric climate has been studied on the ocean at large, it would then be proper to apply the experience gained to the consideration of the more complicated phenomena of the currents.

I am at present engaged in a detailed consideration of the temperature and specific gravity results, principally in the direction above indicated, and hope shortly to be able to send it home for publication.

"On Polishing the Specula of Reflecting Telescopes," by W. Lassell, F.R.S., V.P.R.A.S.

The object of this paper is to describe a method of giving a high lustre and true parabolic curve with ease and certainty, by appropriate machinery, to the surfaces of the specula of large reflecting telescopes.

Linnean Society, Dec. 17.—Dr. Allman, president, in the chair.—Dr. Allman read a paper on "The diagnosis of new genera and species of hydroids," which we will give next week.—Mr. Daniel Hanbury exhibited specimens of an African *Kleinia* which had flowered at Mentone.—Mr. Pryor exhibited branches of the famous "Glastonbury Thorn," noted for always flowering in December.—Sir J. Lubbock, Bart., F.R.S., read "Observations on Bees, Wasps, and Ants." In this paper the author continued the observations read before the Linnean Society last year. In order to test the power of communication which they possessed, he placed various bees on honey, but found that if the honey was out of sight and in a place not frequented by bees, few, if any, others came. For instance, he brought a bee to a honeycomb, weighing 12½ lbs., placed on his writing table; she returned over and over again, but no other bee came. Other experiments of the same kind convinced him that some bees at any rate do not communicate with their sisters, even if they find an untenanted comb full of honey, which to them would be a perfect Eldorado. This is the more remarkable because these bees began to work in the morning before the rest, and continued to do so even in weather which drove all the rest into the shelter of the hive. That a few strange bees should have found the honey is natural enough, because there were a good many bees about in the room. With reference to the affection which bees are said to feel for one another, he observes, that though he had repeatedly seen them lick a bee which had smeared herself in honey, he never observed them show the slightest attention to any of their comrades who had been drowned in water. Far, indeed, from having been able to discover any evidence of affection among them, they appear to be thoroughly callous and utterly indifferent to one another. As already mentioned, it was necessary for him occasionally to kill a bee, but he never found that the others took the slightest notice. Thus, on the 11th of October he crushed a bee close to one which was feeding, in fact so close that their wings touched; yet the survivor took no notice whatever of the death of her sister, but went on feeding with every appearance of composure and enjoyment, just as if nothing had happened. When the pressure was removed, she remained by the side of the corpse without the slightest appearance of apprehension, sorrow, or recognition. It was, of course, impossible for her to understand his reason for killing her companion, yet neither did she feel the slightest emotion at her sister's death, nor did she show any alarm that the same fate should befal her also. In a second case exactly the same occurred. Again, if while a bee is feeding, a second bee is held by the leg close to her, the prisoner, of course, struggles to escape and buzzes as loudly as she can, yet the selfish (?) eater takes no notice whatever. So far, therefore, from being at all affectionate, he doubts whether bees are in the least fond of one another. Their devotion to their queen is generally quoted as a most characteristic trait; yet it is of the most limited character. For instance, on one occasion he changed his black queen for a Ligurian, and placed the old queen with some workers in a box containing some comb. Sir John was obliged to leave home on the following day, but when he returned on the 20th he found that all the bees had deserted the poor queen, who seemed weak, helpless, and miserable. On the 31st the bees were coming to some honey at one of his windows, and he placed this poor queen close to them. In alighting, several of them even touched her, yet not one of them took the slightest notice of her. The same queen, when afterwards placed in the hive, immediately attracted a number of bees. Although the experiments on colour which Sir John has already recorded are tolerably conclusive, still he thought it would be worth while to make some more. For instance, he brought a bee to some honey which he placed on blue paper, and about three feet off he placed a similar quantity of honey on orange paper. After the bee had returned twice he transposed the papers, but she returned to the honey on the blue paper. After she had made three more visits, always to the blue paper, he transposed them again, and she again followed the colour, though the honey was left in the same place. The following day he was not able to watch her, but on the 14th she returned to the honey on the blue paper. He then again transposed the papers. At 8·5 she returned to the old place and was just going to alight, but observing the change of colour, without a moment's hesitation dashed off to the blue. No one, he says, who saw her at that moment could have entertained the slightest doubt about her perceiving the difference between the two colours. He then proceeded to recount some experiments on the sense of smell possessed by bees, on their power of recognising their own companions, and on the different occupations of different bees, mentioning observations which seem to show that the bees act as nurses during the first few weeks of their life, and only subsequently take to collecting honey and pollen. He then proceeded to mention some experiments on wasps, which show that they possess the power of distinguishing colour. In conclusion he recorded a number of experiments on ants, which certainly seemed to show that, whatever may be the case with bees, ants do possess the power of communicating detailed facts to one another. It is remarkable, however, how much individual ants appear to differ from one another in character.

Chemical Society, Dec. 17.—Prof. Gladstone, F.R.S., vice-president, in the chair.—A paper On Groves' method of preparing chlorides, by Dr. Schorlemmer, F.R.S., was read. He finds that the process does not answer well for the higher primary alcohols, although secondary chlorides can readily be prepared by it. The other papers were: On the precipitation of metals by zinc, by Mr. G. L. Davies; Researches on the paraffins existing in Pennsylvanian petroleum, by M. T. M.

* It will be seen that the principle, that the depth to which the effect of the sun's rays penetrates depends on the yearly range of temperature of the water at the surface, explains the presence of the large body of comparatively warm water in the North Atlantic, the existence of which has been usually ascribed to an assumed reflux or back water of the Gulf Stream. The warm water is due to no extraneous cause, but is the natural effect of the conditions of climate at the surface; and the effect of these conditions of climate are so apparent in the temperature of the water, just because it is free from the influence of oceanic currents, and exposed to the effects of climate alone.

Morgan; Some remarks on the preceding paper by Dr. Schlorlemmer; and a Note on Aricine by Mr. D. Howard, who finds that this is really a distinct alkaloid existing in certain kinds of reputed cinchona barks.—The Chairman announced that Prof. C. Maxwell had promised to give a lecture on the 18th of February, On the dynamical evidence of the molecular constitution of bodies.

Meteorological Society, Dec. 16.—Dr. R. J. Muir, president, in the chair.—The following papers were read:—Atmospheric pressure and rainfall, by John C. Bloxam, F.M.S.—Remarks on West India Cyclones, by H. F. Jahncke. This paper is a continuation of a former one read before the Society in February last.—Notes on the weather experienced over the British Isles and the north-west of France during the first few days of October 1874, by R. H. Scott, F.R.S. The object of this paper was to show that the charts in the *Bulletin International* are drawn upon insufficient data. It also recommended the adoption of the conical projection on charts for meteorological purposes.—On a new self-registering hygrometer, by H. Negretti, F.M.S., and J. W. Zambra, F.M.S.—Results of meteorological observations made at and near St. Paul's Island, in the South Indian Ocean, by R. H. Scott, F.R.S.—Description of a new patent portable magnetic anemometer and current meter for maritime use, by R. M. Lowne.

Entomological Society, Dec. 7.—Sir Sidney Smith Saunders, C.M.G., president, in the chair.—Mr. E. A. Fitch exhibited some oak-galls formed by insects of the genera Dryocosmus and Aphilothrix, of which descriptions had been published in a recent number of the *Entomologist's Monthly Magazine*, together with three curious bud-galls, unknown, from Rayleigh, in Essex.—Mr. Champion exhibited a box of Hemiptera, collected by Mr. J. J. Walker in different places near the Mediterranean.—Prof. Westwood forwarded a letter he had received from Mr. Stone, accompanying a sample of tea imported from Shanghae, infested by a small beetle which proved to be the *Ptinus hololeucus*. Also a letter from Prof. Forel, of Lausanne, stating that the *Phylloxera vastatrix* had made its appearance among some vines at Pregny, in the canton of Geneva, which had been introduced from England into the graperies of the Baron Rothschild, and that the Phylloxera had been discovered in two of his greenhouses among vines planted in 1869, sufficiently distant from each other to render it improbable that the insect had been communicated one from the other; and he therefore concluded that the disease had been introduced in 1869 from the graperies in England. He was anxious to ascertain whether the vines in the English graperies were less influenced than those out of doors; but none of the members present were aware of the occurrence of the insect in England out of doors, as it had hitherto appeared in greenhouses only.—Mr. C. O. Waterhouse communicated some "Synonymical Notes on Longicorn Coleoptera."

PARIS

Academy of Sciences, Dec. 14.—M. Frémy in the chair.—The proceedings commenced by M. De Lacaze-Duthiers presenting to the Academy the first two volumes of his "Archives of Experimental Zoology."—The following papers were then read:—On the originating centres of the plague of 1858 and 1874; epidemic nature and contagion of this plague; by M. J. D. Tholozan.—Note on the distribution of water in Egypt and in Greece, by M. Belgrand.—M. Le Verrier presented a new theory of the planet Neptune.—Determination of the velocity of light and of the sun's parallax, by M. A. Cornu. As the mean of 504 experiments, the author has obtained the value 300,000 kilometres per second for the velocity of light *in vacuo*. The determination of the solar parallax is determined in three ways: (1) Observation of the eclipses of Jupiter's satellites—mean result 8"85. (2) Analytical methods founded on the comparison of astronomical observations with theoretical laws based on the principle of gravitation—mean result 8"86. (3) Geometrical methods founded on the parallactic displacement of certain planets. Result obtained from opposition of Mars in 1862 was 8"84.—Observations on the phenomena essential to fertilisation in the fresh-water Algæ of the genus *Batrachospermum*, by M. Sirodot.—Theory of cyclonic meteorological phenomena, by M. Couste.—Observations on the reproduction of the Phylloxera of the vine, by M. Balbiani.—The American species of the genus Phylloxera, by Mr. C. V. Riley. The author recognises sixteen well-defined species.—Method followed in searching for the most efficacious substance to oppose to Phylloxera at the viticultural station of Cognac, by M. Max Cornu.—Experiments made with poisonous agents on healthy vines, by M. Baudrimont.—Telegrams from M. Janssen, director of the Japanese Transit of Venus Expedition, to the Minister of Public Instruction, to the Academy of Sciences, and to the "Bureau des Longitudes," were read. Letters referring to the transit were received also from M. E. Mouchez, director of the station at St. Paul, and from M. Fleuriais, director of the Pekin station.—Observations on Borrelly's last comet, by M. Stéphan.—On the stability of equilibrium of a heavy body resting on a curved support, by M. C. Jordan.—On cubic residues, a note on the theory of numbers, by M. P. Pepin.—On two simple laws of the active resistance of solids, by M. J. Boussinesq. This is a continuation of the former paper bearing this title.—Observations relating to a recent communication by M. Volpicelli on electric induction, by M. E. Blavier.—On the inconvenience of employing vessels of Bohemian glass in chemical analysis, and particularly in alkalimetry, by M. P. Truchot. The author states that French soda glass is not sensibly attacked by boiling water.—On the action of hydrogen on silver nitrate, by M. N. Békétoff. It had been stated by M. Roussel that silver nitrate was reduced by hydrogen, while, on the other hand, M. Pellet maintained that pure hydrogen had no action on solutions of this salt, and that reduction was effected in such cases by the presence of traces of arsenic in the hydrogen employed, or by the presence of an excess of silver oxide in the nitrate. The author of the present communication made, therefore, a series of experiments with carefully purified hydrogen, from which he concludes that this gas does reduce the nitrate either in neutral or feebly acid solutions. The recent researches by Dr. Russell in this country on the same subject do not seem to have come under the author's notice.—Action on the economy of the derivatives of the biliary acids, on the colouring matters of the bile, and on cholesterine, by MM. V. Feltz and E. Ritter.—Anæsthesia produced by the intra-venous injection of chloral in a case of hollowing of the tibia and ovariotomy; acidity of the chloral solution; method of neutralising it, by M. Oré.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—Gums, Resins, Oleo-Resins, and Resinous Products in the India Museum or produced in India: Dr. M. C. Cooke (London, India Museum).—Economic Geology; or, Geology in its relation to Arts and Manufactures: David Page, LL.D., F.C.S., &c. (Wm. Blackwood).—The Last Journals of David Livingstone. 2 vols.: Horace Waller, F.R.G.S. (John Murray).—Origin of Creation; or, the Science of Matter and Force: Thos. R. Fraser and Andrew Dewar (Longmans).—The Botanical Locality Record Club: Report of the Recorder for 1873 (E. Newman).—Anthropological Notes and Queries: British Association (Stanford).—The Conflict between Religion and Science: J. W. Draper, M.D. (H. S. King and Co.)—The Doctrine of Descent and Darwinism. International Series: Oscar Schmitz H. S. King and Co.)

AMERICAN.—The "Babbit Portfolio." New England Society of N.J., (United States).—Memoir of the Founding and Progress of the United States Observatory: Prof. J. E. Nourse, U.S.N. (Washington).

FOREIGN.—Bulletin de la Fédération des Sociétés d'Horticulture de Belgique (Liége).

CONTENTS