NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH

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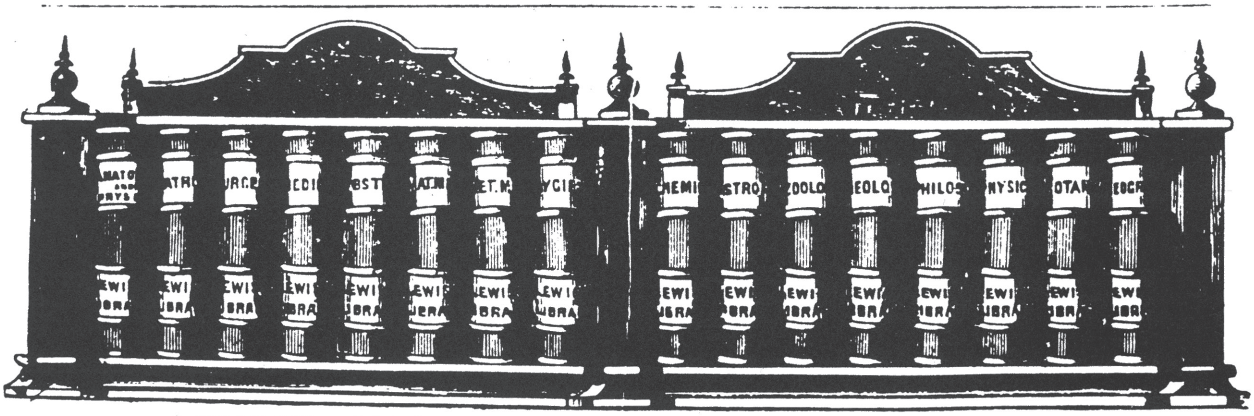

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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, NOVEMBER 4, 1869

NATURE: APHORISMS BY GOETHE

NATURE! We are surrounded and embraced by her: powerless to separate ourselves from her, and powerless to penetrate beyond her.

Without asking, or warning, she snatches us up into her circling dance, and whirls us on until we are tired, and drop from her arms.

She is ever shaping new forms: what is, has never yet been; what has been, comes not again. Everything is new, and yet nought but the old.

We live in her midst and know her not. She is incessantly speaking to us, but betrays not her secret. We constantly act upon her, and yet have no power over her.

The one thing she seems to aim at is Individuality; yet she cares nothing for individuals. She is always building up and destroying; but her workshop is inaccessible.

Her life is in her children; but where is the mother? She is the only artist; working-up the most uniform material into utter opposites; arriving, without a trace of effort, at perfection, at the most exact precision, though always veiled under a certain softness.

Each of her works has an essence of its own; each of her phenomena a special characterisation: and yet their diversity is in unity.

She performs a play; we know not whether she sees it herself, and yet she acts for us, the lookers-on.

Incessant life, development, and movement are in her, but she advances not. She changes for ever and ever, and rests not a moment. Quietude is inconceivable to her, and she has laid her curse upon rest. She is firm. Her steps are measured, her exceptions rare, her laws unchangeable.

She has always thought and always thinks; though not as a man, but as Nature. She broods over an all-comprehending idea, which no searching can find out.

Mankind dwell in her and she in them. With all men she plays a game for love, and rejoices the more they win. With many, her moves are so hidden, that the game is over before they know it.

That which is most unnatural is still Nature; the stupidest philistinism has a touch of her genius. Whoso cannot see her everywhere, sees her nowhere rightly.

She loves herself, and her innumerable eyes and affections are fixed upon herself. She has divided herself that she may be her own delight. She causes an endless succession of new capacities for enjoyment to spring up, that her insatiable sympathy may be assuaged.

She rejoices in illusion. Whoso destroys it in himself and others, him she punishes with the sternest tyranny. Whoso follows her in faith, him she takes as a child to her bosom.

Her children are numberless. To none is she altogether miserly; but she has her favourites, on whom she squanders much, and for whom she makes great sacrifices. Over greatness she spreads her shield.

She tosses her creatures out of nothingness, and tells them not whence they came, nor whither they go. It is their business to run, she knows the road.

Her mechanism has few springs—but they never wear out, are always active and manifold.

The spectacle of Nature is always new, for she is always renewing the spectators. Life is her most exquisite invention; and death is her expert contrivance to get plenty of life.

She wraps man in darkness, and makes him for ever long for light. She creates him dependent upon the earth, dull and heavy; and yet is always shaking him until he attempts to soar above it.

She creates needs because she loves action. Wondrous! that she produces all this action so easily. Every need is a benefit, swiftly satisfied, swiftly renewed.—Every fresh want is a new source of pleasure, but she soon reaches an equilibrium.

Every instant she commences an immense journey, and every instant she has reached her goal.

She is vanity of vanities; but not to us, to whom she has made herself of the greatest importance. She allows every child to play tricks with her; every fool to have judgment upon her; thousands to walk stupidly over her and see nothing; and takes her pleasure and finds her account in them all.

We obey her laws even when we rebel against them; we work with her even when we desire to work against her.

She makes every gift a benefit by causing us to want it. She delays, that we may desire her; she hastens, that we may not weary of her.

She has neither language nor discourse; but she creates tongues and hearts, by which she feels and speaks.

Her crown is love. Through love alone dare we come near her. She separates all existences, and all tend to intermingle. She has isolated all things in order that all may approach one another. She holds a couple of draughts from the cup of love to be fair payment for the pains of a lifetime.

She is all things. She rewards herself and punishes herself; is her own joy and her own misery. She is rough and tender, lovely and hateful, powerless and omnipotent. She is an eternal present. Past and future are unknown to her. The present is her eternity. She is beneficent. I praise her and all her works. She is silent and wise.

No explanation is wrung from her; no present won from her, which she does not give freely. She is cunning, but for good ends; and it is best not to notice her tricks.

She is complete, but never finished. As she works now, so can she always work. Everyone sees her in his own fashion. She hides under a thousand names and phrases, and is always the same. She has brought me here and will also lead me away. I trust her. She may scold me, but she will not hate her work. It was not I who spoke of her. No! What is false and what is true, she has spoken it all. The fault, the merit, is all hers.

So far Goethe.

When my friend, the Editor of NATURE, asked me to write an opening article for his first number, there came into my mind this wonderful rhapsody on "Nature," which has been a delight to me from my youth up. It seemed to me that no more fitting preface could be put before a Journal, which aims to mirror the progress of that fashioning by Nature of a picture of herself, in the mind of man, which we call the progress of Science.

A translation, to be worth anything, should reproduce the words, the sense, and the form of the original. But when that original is Goethe's, it is hard indeed to obtain this ideal; harder still, perhaps, to know whether one has reached it, or only added another to the long list of those who have tried to put the great German poet into English, and failed.

Supposing, however, that critical judges are satisfied with the translation as such, there lies beyond them the chance of another reckoning with the British public, who dislike what they call "Pantheism" almost as much as I do, and who will certainly find this essay of the poet's terribly Pantheistic. In fact, Goethe himself almost admits that it is so. In a curious explanatory letter, addressed to Chancellor von Müller, under date May 26th, 1828, he writes:—

"This essay was sent to me a short time ago from amongst the papers of the ever-honoured Duchess Anna Amelia; it is written by a well-known hand, of which I was accustomed to avail myself in my affairs, in the year 1780, or thereabouts.

"I do not exactly remember having written these reflections, but they very well agree with the ideas which had at that time become developed in my mind. I might term the degree of insight which I had then attained, a comparative one, which was trying to express its tendency towards a not yet attained superlative.

"There is an obvious inclination to a sort of Pantheism, to the conception of an unfathomable, unconditional, humorously self-contradictory Being, underlying the phenomena of Nature; and it may pass as a jest, with a bitter truth in it."

Goethe says, that about the date of this composition of "Nature" he was chiefly occupied with comparative anatomy; and, in 1786, gave himself incredible trouble to get other people to take an interest in his discovery, that man has a intermaxillary bone. After that he went on to the metamorphosis of plants, and to the theory of the skull; and, at length, had the pleasure of seeing his work taken up by German naturalists. The letter ends thus:—

"If we consider the high achievements by which all the phenomena of Nature have been gradually linked together in the human mind; and then, once more, thoughtfully peruse the above essay, from which we started, we shall, not without a smile, compare that comparative, as I called it, with the superlative which we have now reached, and rejoice in the progress of fifty years."

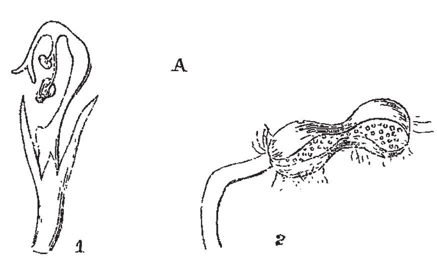
Forty years have passed since these words were written, and we look again, "not without a smile," on Goethe's superlative. But the road which led from his comparative to his superlative, has been diligently followed, until the notions which represented Goethe's superlative are now the commonplaces of science—and we have a super-superlative of our own.

When another half-century has passed, curious readers of the back numbers of NATURE will probably look on *our* best, "not without a smile;" and, it may be, that long after the theories of the philosophers whose achievements are recorded in these pages, are obsolete, the vision of the poet will remain as a truthful and efficient symbol of the wonder and the mystery of Nature. T. H. HUXLEY

ON THE FERTILISATION OF WINTER-FLOWERING PLANTS

THAT the stamens are the male organ of the flower, forming unitedly what the older writers called the "andrœcium," is a fact familiar not only to the scientific man, but to the ordinary observer. The earlier botanists formed the natural conclusion that the stamens and pistil in a flower are intended mutually to play the part of male and female organs to one another. Sprengel was the first to point out, about the year 1790, that in many plants the arrangement of the organs is such, that this mutual interchange of offices in the same flower is impossible; and more recently, Hildebrand in Germany, and Darwin in England, have investigated the very important part played by insects in the fertilisation of the pistil of one individual by the stamens of another individual of the same species. It is now generally admitted by botanists that cross-fertilisation is the rule rather than the exception. The various contrivances for ensuring it, to which Mr. Darwin has especially called the attention of botanists, are most beautiful and interesting; and the field thus opened out is one which, from its extent, importance, and interest, will amply repay the investigation of future observers. For this cross-fertilisation to take place, however, some foreign agency like that of insects is evidently necessary, for conveying the pollen from one flower to another. The question naturally occurs, How then is fertilisation accomplished in those plants which flower habitually in the winter, when the number of insects that can assist in it is at all events very small? I venture to offer the following notes as a sequel to Mr. Darwin's observations, and as illustrating a point which has not been elucidated by any investigations that have yet been recorded. I do not here refer to those flowers of which, in mild seasons, stray half-starved specimens may be found in December or January, and of which we are favoured with lists every year in the corners of newspapers, as evidence of "the extraordinary mildness of the season." I wish to call attention exclusively to those plants, of which we have a few in this country, whose normal time of flowering is almost the depth of winter, like the hazel-nut *Corylus avellana*, the butcher's broom *Ruscus aculeatus*, and the gorse *Ulex europæus;* and to that more numerous class which flower and fructify all through the year, almost regardless of season or temperature; among which may be mentioned the white and red dead-nettles *Lamium album* and *purpureum*, the *Veronica Buxbaumii*, the daisy, dandelion, and groundsel, the common spurge *Euphorbia peplus*, the shepherd's purse, and some others.

During the winter of 1868-69, I had the opportunity of making some observations on this class of plants; the result being that I found that, as a general rule, fertilisation, or at all events the discharge of the pollen by the anthers, takes place in the bud before the flower is opened, thus ensuring *self-fertilisation* under the most favourable circumstances, with complete protection from the weather, assisted, no doubt, by that rise of temperature which is known to take place in certain plants at the time of flowering. The dissection of a flower of *Lamium album* (Fig. A) gathered the last week in December, showed the stamens completely curved down and brought almost into contact with the bifid stigma, the pollen being at that time freely discharged from the anthers. A more complete contrivance for self-fertilisation than is here presented would be impossible. The same phenomena were observed in *Veronica Buxbaumii*, where the anthers are



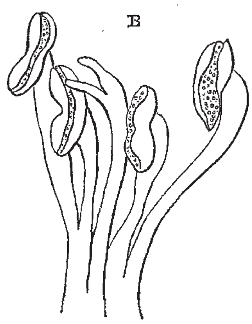
A. LAMIUM ALBUM.
1. Section of bud, calyx and corolla removed.
2. Stamen from bud, enlarged, discharging pollen.

almost in contact with the stigma before the opening of the flower, which occurs but seldom, *V. agrestis* and *polita*, the larger periwinkle *Vinca major*, the gorse, dandelion, groundsel, daisy, shepherd's purse, in which the four longer stamens appear to discharge their pollen in the bud, the two shorter ones not till a later period, *Lamium purpureum*, *Cardamine hirsuta*, and the chickweed *Stellaria media*, in which the flowers open only under the influence of bright sunshine. In nearly all these cases, abundance of fully-formed, seed-bearing capsules were observed in the specimens examined, all the observations being made between the 28th of December and the 20th of January.

In contrast with these was also examined a number of wild plants which had been tempted by the mild January to put forth a few wretched flowers at a very abnormal season, including the charlock *Sinapis arvensis*, wild thyme *Thymus serpyllum*, and fumitory *Fumaria officinalis;* in all of which instances was there not only no pollen discharged before the opening of the flower, but no seed was observed to be formed. An untimely specimen of the common garden bean *Faba vulgaris*, presented altogether different phenomena from its relative the gorse, the anthers not discharging their pollen till after the opening of the flower; and the same was observed in the case of the *Lamium Galeobdolon* or yellow archangel (Fig. B) gathered in April, notwithstanding its consanguinity to the dead-nettle.

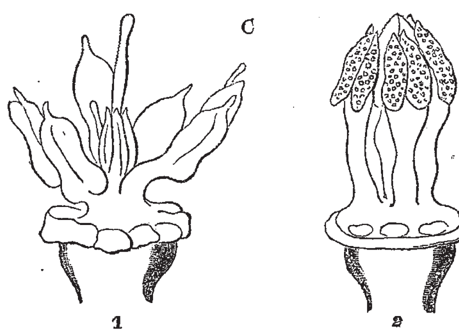
Another beautiful contrast to this arrangement is afforded by those plants which, though natives of warmer climates, continue to flower in our gardens in the depth of winter. An example of this class is furnished by the common yellow jasmine, *Jasminium nudiflorum*, from

China, which does not discharge its pollen till considerably after the opening of the flower, and which never fructifies in this country. But a more striking instance is found in the "allspice tree," the *Chimonanthus fragrans*, or *Calycanthus præcox* of gardeners, a native of Japan, which,



B. Lamium Galeobdolon.—Pistil and stamens from open flower; the latter discharging pollen.

flowering soon after Christmas, has yet the most perfect contrivance to prevent self-fertilisation (Fig. C). In a manner very similar to that which has been described in the case of *Parnassia palustris*,* the stamens, at first nearly horizontal, afterwards lengthen out, and rising up perpendicularly, completely cover up the pistil, and then discharge their pollen outwardly, so that none can possibly fall on the stigma. As a necessary consequence, fruit is never produced in this country; but may we not conjecture that in its native climate the *Chimonanthus* is



C. Chimonanthus fragrans

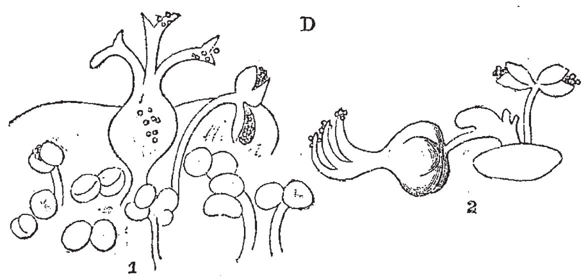
1. Early stage of flower, calyx and corolla removed.
2. Later stage, stamens surrounding the pistil, and discharging their pollen outwardly.

abundantly cross-fertilised by the agency of insects, attracted by its delicious scent, in a similar manner to our Grass of Parnassus?

The description detailed above cannot of course apply to those winter-flowering plants in which the male and female organs are produced on different flowers; but here we find commonly another provision for ensuring fertilisation. In the case of the hazel-nut the female flowers number from two to eight or ten in a bunch, each flower containing only a single ovule destined to ripen. To each bunch of female flowers belongs at least one catkin (often two or three) of male flowers, consisting of from 90 to 120 flowers, and each flower containing from three to eight anthers. The pollen is not discharged till the stigmas are fully developed, and the number of pollen-grains must be many thousand times in excess of what would be required were each grain to take effect. The arrangement in catkins also favours the scattering of the pollen by the least breath of wind, the reason probably why so many of the timber-trees in temperate climates, many of them flowering very early in the season, have their male inflorescence in this form.

* Journal of the Linnæan Society for 1868-69, Botany, p. 24.

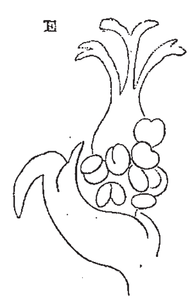
The *Euphorbias* or spurges have flowers structurally unisexual, but which, for physiological purposes, may be regarded as bisexual, a single female being enclosed along with a large number of male flowers in a common envelope of involucral glands. Two species are commonly found flowering in the winter, and producing abundance of capsules, *E. peplus* and *helioscopia*. In both these species the pistil makes its appearance above the involucral glands considerably earlier than the bulk of the stamens (Fig. D).



D. Euphorbia helioscopia

1. Head of flowers opened, pistil and single stamen appearing above the involucral glands.
2. The same somewhat later, with the stigmas turned upwards.

A single one, however, of these latter organs was observed to protrude beyond the glands simultaneously, or nearly so, with the pistil, and to discharge its pollen freely on the stigmas, thus illustrating a kind of quasi-self-fertilisation. The remaining stamens do not discharge their pollen till a considerably later period, after the capsule belonging to the same set has attained a considerable size. In *E. helioscopia* the capsules are always entirely included within the cup-shaped bracts, and the stigmas are turned up at the extremity so as to receive the pollen freely from their own stamens. Now contrast with this the structure of *E. amygdaloides*, which does not flower before April (Fig. E). The heads of flowers which first open are entirely male, containing no female flower; in the hermaphrodite heads, which open subsequently, the stigmas are completely



E. Euphorbia amygdaloides.—Head of flower, pistil appearing above the involucral glands, all the stamens still undischarged.

exposed beyond the involucral glands long before any stamens protrude from the same glands. Here, therefore, complete cross-fertilisation takes place, the pollen from the first-opened male heads no doubt fertilising the stigma from the next-opened hermaphrodite heads, and so on. In this species the bracts are not cup-shaped, but nearly flat; the stigmas hang out very much farther than in *E. helioscopia;* and the styles are perfectly straight.

The above observations are very imperfect as a series, and I can only offer them as a contribution towards an investigation of the laws which govern the cross-fertilisation or self-fertilisation of winter-flowering plants. On communicating some of them to Mr. Darwin, he suggested that the self-fertilised flowers of *Lamium album,* and other similar plants, may possibly correspond to the well-known imperfect self-fertilised flowers of *Oxalis* and *Viola;* and that the flowers produced in the summer are cross-fertilised; a suggestion which I believe will be found correct.

In conclusion, I may make two observations. The time of flowering of our common plants given in our text-books is lamentably inexact; for the hazel, March and April for instance! and for the white dead-nettle, May and June! according to Babington. Great care also should be taken to examine the flowers the moment they are brought in-doors; as the heat of the room will often cause the anthers to discharge their pollen in an incredibly short space of time. This is especially the case with the grasses.

Alfred W. Bennett

PROTOPLASM AT THE ANTIPODES

THE Protoplasm excitement seems to have died away in a great measure in this country; and it is probably no loss to science that the matter has ceased to be a prevailing topic of conversation at dinner tables. We learn, however, from the Melbourne papers, that the arrival of the February number of the *Fortnightly Review* in the Australian colonies gave rise to an epidemic there of controversial science in a very alarming form. The description they give of the intellectual condition of Melbourne in June and July last, in fact, reminds us of that famous time at Constantinople, when a cobbler would not mend a pair of shoes until he had converted his customer from a Homousian to a Homoiousian, or *vice versâ.* The *Melbourne Daily Telegraph* is proud to think that a city which a few years back could only be stirred by a "Jumping Frog," is now agitated by proteinaceous theories; and this, too, in spite of the fact that they had previously been warned by the scientific correspondent of the *Melbourne Leader* of Mr. Huxley's gross ignorance and sensational superficiality. It is perfectly well known that at home here Mr. Huxley has been refuted many more times than there are copies of his article; but in Melbourne he was refuted over again afresh. We learn that the Rev. H. Higginson, "in a singularly able discourse at the Unitarian Church, tore the theory to shreds in a way"—reports the *Argus* with felicitous dubiety—"which showed the preacher to be as keen a humorist as he is a subtle logician." So able was the discourse, and so humorous, that it was repeated shortly afterwards as a lecture at the Mechanics' Institute. Here, however, the lecturer stated that it was a mistake to suppose that he had in the sermon either torn the theory to shreds or treated it in a humorous way; and the report of the lecture lends great support to the statement.

It may be perhaps gratifying to Mr. Huxley, to think that he has stirred men's minds in a place which was almost a *terra incognita* when the unknown young assistant-surgeon of the *Rattlesnake* looked upon it; but the papers tell us that a reprint of the *Fortnightly* article has been the first instance of infringement of copyright in that colony; and when the learned anatomist was speaking at Edinburgh he probably little thought that materialism would take its revenge on him by producing the following exercise in applied Biology:—

The Physical Basis of Life.

Huxley's celebrated Essay on this subject is lectured on daily, by

William Barton,

who has made the matter a life study. It is also illustrated daily at his tables, where the "physical basis" can be laid in from 11 to 3, in the best cooked and most varied

Hot Luncheon

in the city.

The first feeling which comes to the mind after such things as these is an unbounded belief in the wisdom of those old teachers who kept esoteric and exoteric doctrines wide apart, and who laid bare the workings of their minds to trusted scholars only, and never to the vulgar gaze. We begin fervently to wish that our illustrious biologist had not, by the dress and mode of his lecture, so laid great biological truths before the public as to excite those especially ignorant of the science of life to try and trample them under foot, and then leave them for a vulgar tavern-keeper to hang up for a sign.

Second—better—thoughts, however, remind us that men of science work not for themselves, or for their scientific fellows, but for mankind; and that only mischief can come of it if they whose business it is to ask Nature her secrets are hindered from telling the world all that they think they hear. It is impossible to separate science from other knowledge and from daily life: all new discoveries especially must have ties with every part of our nature. It is not the business of the biologist to enforce on others what he believes to be the consequences of his biological discoveries; but it is certainly not his duty to withhold his facts from the common people because of the results which he thinks will follow.

And in regard to Australia in particular, we have this reflection, that the plough is needful for the seed; heavy land wants well turning up. There are not wanting signs that a national character is beginning to form among the inhabitants of that country; and we trust that scientific zeal will be one of its chief features. We hope that science even in a controversial form will never again give way in Melbourne to the vain delights of the "Jumping Frog;" and that the protoplasm which Mr. William Barton so admirably cooks will reappear in the nerve cells of Australian brains, and give rise to that love of truth, apart from gold or gain, which is the "moral" basis of "national" life. We may add that we hope not without confidence; for a bright example of conscientious truthfulness appeared in the midst of this small biological tempest. Many of our readers may remember the abundant fervour with which Prof. Halford, some years since, attacked Mr. Huxley's "Man's Place in Nature." At the end of Mr. Higginson's lecture the talented Melbourne anatomist courageously told the meeting, that he had seen reason to change his opinions. Every one here will rejoice to receive from the Antipodes a lesson of self-denial and moral daring, not too common amongst ourselves.

THE RECENT TOTAL ECLIPSE OF THE SUN

IF our American cousins in general hesitate to visit our little island, lest, as some of them have put it, they should fall over the edge; those more astronomically inclined may very fairly decline, on the ground that it is a spot where the sun steadily refuses to be eclipsed. This is the more tantalising, because the Americans have just observed their third eclipse this century, and already I have been invited to another, which will be visible in Colorado, four days' journey from Boston (I suppose I am right in reckoning from Boston?) on July 29, 1878.

Thanks to the accounts in *Silliman's Journal* and the *Philosophical Magazine*, and to the kindness of Professors Winlock and Morton, who have sent me some exquisite photographs, I have a sufficient idea of the observations of this third eclipse, which happened on the 7th of August last, to make me anxious to know very much more about them—an idea sufficient also, I think, to justify some remarks here on what we already know.

A few words are necessary to show the work that had to be done.

An eclipse of the sun, so beautiful and yet so terrible to the mass of mankind, is of especial value to the astronomer, because at such times the dark body of the moon, far outside our atmosphere, cuts off the sun's light from it, and round the place occupied by the moon and moon-eclipsed sun there is therefore none of the glare which we usually see—a glare caused by the reflection of the sun's light by our atmosphere. If, then, there were anything surrounding the sun ordinarily hidden from us by this glare, we ought to see it during eclipses.

In point of fact, strange things are seen. There is a strange halo of pearly light visible, called the corona, and there are strange red things, which have been called red flames or red prominences, visible nearer the edge of the moon—or of the sun which lies behind it.

Now, although we might, as I have pointed out, have these things revealed to us during eclipses if they belonged to the sun, it does not follow that they belong to the sun because we see them. Halley, a century and a half ago, was, I believe, the first person to insist that they were appearances due to the moon's atmosphere, and it is only within the last decade that modern science has shown to everybody's satisfaction—by photographing them, and showing that they were eclipsed as the sun was eclipsed, and did not travel with the moon—that the red prominences really do belong to the sun.

The evidence, with regard to the corona, was not quite so clear; but I do not think I shall be contradicted when I say, that prior to the Indian eclipse last year the general notion was that the corona was nothing more nor less than the atmosphere of the sun, and that the prominences were things floating in that atmosphere.

While astronomers had thus been slowly feeling their way, the labours of Wollaston, Herschel, Fox Talbot, Wheatstone, Kirchhoff, and Bunsen, were providing them with an instrument of tremendous power, which was to expand their knowledge with a suddenness almost startling, and give them previously undreamt-of powers of research. I allude to the spectroscope, which was first successfully used to examine the red flames during the eclipse of last year. That the red flames were composed of hydrogen, and that the spectroscope enabled us to study them day by day, were facts acquired to science independently by two observers many thousand miles apart.

The red flames were "settled," then, to a certain extent; but what about the corona?

After I had been at work for some time on the new method of observing the red flames, and after Dr. Frankland and myself had very carefully studied the hydrogen spectrum under previously untried conditions, we came to the conclusion that the spectroscopic evidence brought forward, both in the observatory and in the laboratory, was against any such extensive atmosphere as the corona had been imagined to indicate; and we communicated our conclusion to the Royal Society. Since that time, I confess, the conviction that the corona is nothing else than an effect due to the passage of sunlight through our own atmosphere near the moon's place has been growing stronger and stronger; but there was always this consideration to be borne in mind, namely, that as the spectroscopic evidence depends mainly upon the brilliancy of the lines, that evidence was in a certain sense negative only, as the glare might defeat the spectroscope with an uneclipsed sun in the coronal regions, where the temperature and pressure are lower than in the red-flame region.

The great point to be settled then, in America, was, What is the corona? and there were many less ones. For instance, by sweeping round the sun with the spectroscope, both before and after the eclipse, and observing the prominences with the telescope merely during the eclipse, we

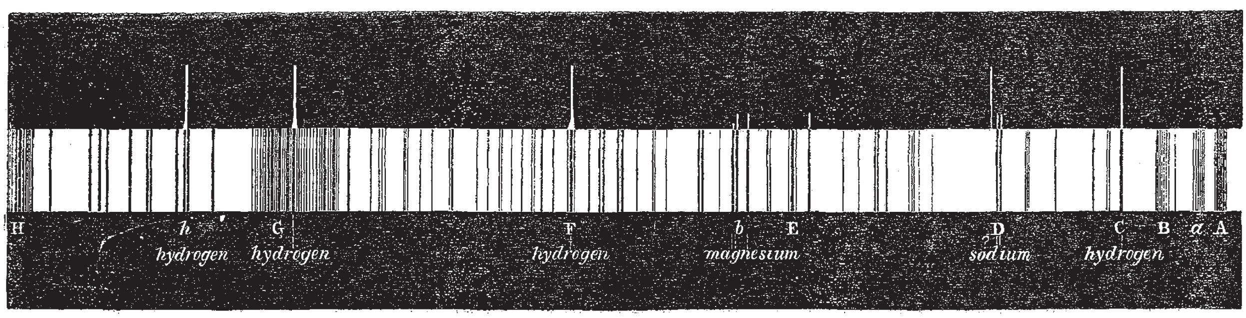


FIG. 1.—Showing the solar spectrum, with the principal Fraunhofer lines, and above it the bright-line spectrum of a prominence containing magnesium, sodium, and iron vapour at its base.

should get a sort of key to the strange cypher band called the spectrum, which might prove of inestimable value, not only in the future, but in a proper understanding of all the telescopic observations of the past. We should, in fact, be thus able to translate the language of the spectroscope. Again, by observing the spectrum of the same prominence both before and during, or during and after the eclipse, the effect of the glare on the visibility of the lines could be determined—but I confess I should not like to be the observer charged with such a task.

What, then, is the evidence furnished by the American observers on the nature of the corona? It is *bizarre* and puzzling to the last degree! The most definite statement on the subject is, that it is nothing more nor less than a *permanent solar aurora!* the announcement being founded on the fact, that three bright lines remained visible after the image of a prominence had been moved away from the slit, and that one (if not all) of these lines is coincident with a line (or lines) noticed in the spectrum of the aurora borealis by Professor Winloch.

Now it so happens that among the lines which I have observed up to the present time—some forty in number—this line is among those which I have most frequently recorded: it is, in fact, the first iron line which makes its appearance in the part of the spectrum I generally study when the iron vapour is thrown into the chromosphere. Hence I think that I should always see it if the corona were a permanent solar aurora, and gave out this as its brightest line; and on this ground alone I should hesitate to regard the question as settled, were the new hypothesis less startling than it is. The position of the line is approximately shown in the woodcut (Fig. 1) near E, together with the other lines more frequently seen.

It is only fair, however, to Professor Young, to whom is due this important observation, to add that Professor Harkness also declares for one bright line in the spectrum of the corona, but at the same time he, Professor Pickering, and indeed others, state its spectrum to be also continuous, a remark hard to understand unless we suppose the slit to have been wide, and the light faint, in either of which cases final conclusions can hardly be drawn either way.

So much, then, for the spectroscopic evidence with which we are at present acquainted on the most important point. The results of the other attacks on the same point are equally curious and perplexing. Formerly, a favourite argument has been that because the light of the corona is polarised; therefore it is solar. The American observers state that the light is *not* polarised—a conclusion, as M. Faye has well put it, "very embarrassing for Science." Further,—stranger still if possible,—it is stated that another line of inquiry goes to show that, after all, Halley may be right, and that the corona may really be due to a lunar atmosphere.

I think I have said enough to show that the question of the corona is by no means settled, and that the new method has by no means superseded the necessity of carefully studying eclipses; in fact, their observation has become of much greater importance than before; and I earnestly hope that all future eclipses in the civilised area in the old world will be observed with as great earnestness as the last one was in the new. Certainly, never before was an eclipsed sun so thoroughly tortured with all the instruments of Science. Several hundred photographs were taken, with a perfection of finish which may be gathered from the accompanying reproduction of one of them.

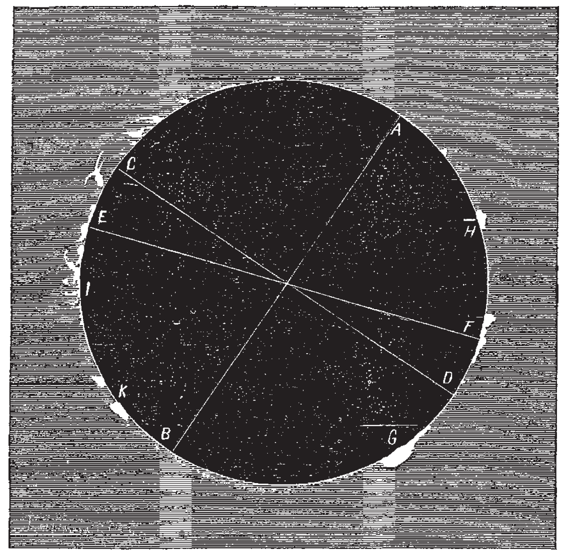


FIG. 2.—Copy of a photograph of the Eclipse of August 7, obtained by Professor Morton's party

The Government, the Railway and other companies, and private persons threw themselves into the work with marvellous earnestness and skill; and the result was that the line of totality was almost one continuous observatory, from the Pacific to the Atlantic. We read in *Silliman's Journal*, "There seems to have been scarcely a town of any considerable magnitude along the entire line, which was not garrisoned by observers, having some special astronomical problem in view." This was as it should have been, and the American Government and men of science must be congratulated on the noble example they have shown to us, and the food for future thought and work they have accumulated.

J. NORMAN LOCKYER

Since writing the above, I find the following independent testimony in favour of Dr. Frankland's and my own notion of the corona in the *Astronomische Nachrichten*, from the pen of Dr. Gould. He says:—"Its form varied continually, and I obtained drawings for three epochs at intervals of one minute. It was very irregular in form, and in no apparent relation with the protuberances on the sun, or the position of the moon. Indeed, there were many phenomena which would almost lead to the belief that it was an atmospheric rather than a cosmical phenomenon. One of the beams was at least 30′ long."

MADSEN'S DANISH ANTIQUITIES

Antiquités préhistoriques du Danemarck. By M. Madsen. Folio, pp. 19, with 45 engraved plates, some coloured. Price 36*s*. (London: Williams and Norgate.)

THIS work contains forty-five carefully executed plates of Danish Antiquities belonging to the Stone age. The first represents the Shellmound of Fannerup; a difficult subject, very faithfully rendered, as the present writer can testify. The three following plates give the common and characteristic objects of the Shellmounds. Then follow ten plates devoted to tumuli and dolmens. These are admirably executed, those of the great chambered tumulus at Uby being particularly successful. Plates xv. to xx. give certain remarkable "finds." These are very interesting, 50 objects discovered together being more instructive than 500 found separately. On the remaining plates are represented the most characteristic Danish forms, as well as many unique specimens. The work is devoted to the Stone age (the Bronze age portion, though commenced, not being yet completed), but it must not be supposed that all the specimens of stone implements here figured necessarily belong to the Stone age, although the great majority no doubt do so. It cannot, however, be too often repeated that many stone implements were in use during the Bronze age.

Everyone looking even cursorily at these plates must be struck by the excellence of the Danish flint, and the wonderful mastery which had been acquired over it. The daggers, for instance, represented in Pl. xxxv. are extraordinary instances of skill in flint chipping, and it must be confessed that such masterpieces could hardly be found in any country but Denmark.

It will be observed also that all the specimens figured belong, or may have belonged, to the Neolithic or second Stone period; there is not in the whole series, nor I believe is there in any of the great Danish museums, a single specimen of the characteristic Paleolithic forms. The rarity of the reindeer and of the mammoth renders this still more significant. We suppose that no one could look through these plates and yet retain any doubts as to the important part played by stone, and especially flint implements, in ancient times; though we must confess that we once showed our collection to a lady, who remained incredulous almost to the last, until we came to a drawer containing a roedeer's horn, which she at once said was evidently of human workmanship, and showed much skill.

The letterpress attached to the plates is confined to twenty pages, of which nine contain an introduction, the rest giving descriptions of the plates. It would, we admit, have been scarcely worth while to describe each specimen figured, but we regret that, excepting as regards the first few plates, no information is given as to the localities in, and the circumstances under, which they were discovered.

The introduction represents very fairly the general opinion of Danish archæologists, and with it we in the main concur. M. Madsen points out that the large, chambered, tumuli never contain metal, and, like Steenstrup, he doubts whether during that period the inhabitants of Denmark had any other domestic animal than the dog. No doubt some modern races, for instance the Polynesians, present this condition; but then their islands contained no cattle or sheep. It is, we think, very improbable that a people capable of such considerable constructions as the chambered tumuli, would not have tamed the wild cattle of the country.

Neither can we agree with M. Madsen and the Danish antiquaries in fixing the commencement of the Danish Iron age so late as the third century. We know that in southern Europe the use of iron commenced several hundred years earlier, and the great similarity of the bronze weapons all over Europe indicates clearly, we think, that they belonged to one and the same period. We cannot but think that the use of iron, when once discovered, would have spread rapidly over Europe, though it would, no doubt, have remained scarce in a comparatively poor country, as Denmark then was.

Lest our readers should suppose that a book containing more than forty beautifully executed plates must necessarily be very expensive, we may mention that the price is only *1l. 16s.* We heartily thank M. Madsen for this valuable addition to our Archæological Libraries.—JOHN LUBBOCK

NEWMAN'S BRITISH MOTHS

An Illustrated Natural History of British Moths. By Edward Newman, F.L.S. F.Z.S. &c. Large 8vo. pp. 486. (London: W. Tweedie.)

A HUNDRED years ago, or perhaps even less, a man who displayed a fondness for collecting insects was commonly regarded as a weak-minded individual, whose power of managing his own affairs, although it might in charity be conceded by his neighbours, was at least somewhat doubtful. To use the old Scotch phrase, he was supposed to have "a Bee in his bonnet," because he liked to have a Butterfly under his eyes.

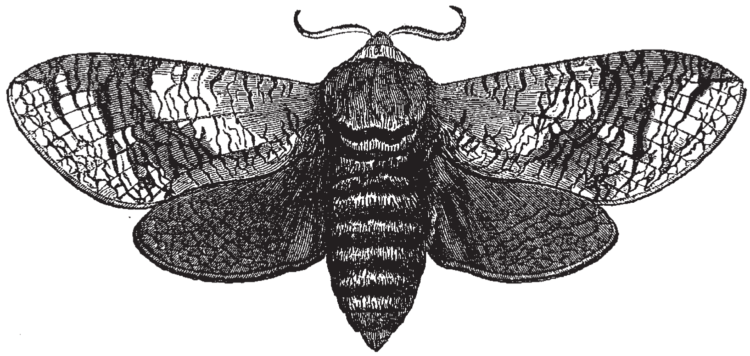
In the present day, although many people may be found who cannot see the use of such pursuits, one runs no risk of a commission *de lunatico,* on account of a predilection for moths or beetles; and if we may judge from the articles provided for the delectation of the multitude in our popular journals, natural history subjects, including entomology, form a not unattractive portion of their bill of fare.

The fact is, that the *cacoëthes colligendi* is one of the commonest affections of humanity, and there are few forms of the disease more harmless than the entomological one. Pictures and statues, books, prints and old china, call for a very considerable expenditure of hard cash, if it is desired to form ever so small a collection of any of them; but the insect-collector generally brings his treasures together by the labour of his own hands, and his boxes and pins do not cost much. Moreover, the collector of insects can hardly avoid learning something of the structure and habits of the objects of his pursuit—a knowledge which must have a favourable effect upon his own mind, and may frequently enable him to be serviceable to his neighbours.

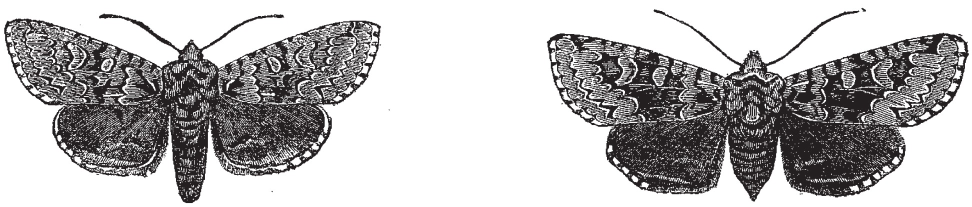
Mr. Newman's "History of British Moths," which is now completed so far as the larger forms are concerned, is admirably adapted to favour these desirable objects; it not only furnishes good descriptions of the British species of moths, but gives an account of their habits in all stages of their existence. This book, which forms a handsome octavo volume, will be welcomed with enthusiasm by numbers of young entomologists in all parts of the country, as it gives them, in a convenient and intelligible form, pretty nearly all that can be told about the great group of insects of which it treats. It has another claim upon their attention also in the admirably executed woodcuts with which it is illustrated. Mr. Newman has given figures of every species, in many cases of both sexes of the species, and sometimes of their most prominent varieties, and these figures, although from their nature they are only in black and white, have been so carefully drawn, and so admirably cut, that the want of colour is hardly felt.

We reproduce here two of the cuts, which will show how effective the illustrations are. To the country entomologist working at a distance from any library, whence he can obtain the expensive illustrated works in which these insects are represented on coloured plates, these figures, accompanied as they are by good descriptions, will prove an invaluable boon; and we can only hope that Mr. Newman's book, the result of years of study, may meet with the success which it so well deserves.

W. S. DALLAS



THE GOAT MOTH (*Cossus ligniperd*)



THE MERVEILLE DU JOUR (*Agriopis aprilina*)

OUR BOOK SHELF

Text Book of Botany.—*Lehrbuch der Botanik für Gymnasien, Realschulen, &c.* By Dr. Otto W. Thomé. 1 vol. 8vo. 358 pp., with 621 woodcuts. Price 3*s.* (Brunswick, 1869.)

DR. THOMÉ'S name is new to us. He is a teacher in what we may call the Upper Grammar School at Cologne. Because he has not published original observations it does not follow that he should be a bad teacher. Rather, indeed, this is a point in his favour; for original observers, unless they be men of wide grasp of mind, or of great experience, are apt to ride special hobbies too far, and to be very unfair and crotchety.

A cursory inspection of this book leaves a favourable impression. It is German, of course, and the first chapter is entitled *Die Zelle als Individuum*, but so far as we can judge it is a handy book for a beginner, and if not all pure milk, it does not seem very badly diluted: much cream now-a-days it is hardly fair to look for. It is very copiously illustrated; the cuts by no means all original, and not a few borrowed from this side the Channel, but none the less well adapted to their purpose. D. O.

The Retardation of the Beat of the Heart.—*Das Hemmungsnervensystem des Herzens.* By Adolf Bernhard Meyer. (Berlin, 1869. London: Williams and Norgate.)

A CRITICAL and experimental inquiry into the inhibitory action of the pneumogastric nerve on the beat of the heart. The chief features of the experimental investigation are—first, the extension of the facts of inhibition to many animals (chiefly reptiles) not hitherto specially examined in reference to this point. Curiously enough, in *Emys lutaria* the left pneumogastric is inert; unfortunately Dr. Meyer has not worked out the cause of this singularity. Second, the author brings experiments to show that the effect of stimulation on the pneumogastric may be kept up for a very long time—more than an hour. In frogs the effect may be carried as far as complete stoppage for this time; in mammals as far as retardation only of the beat. M. F.

Exotic Lepidoptera.—*Lepidoptera Exotica; or, Descriptions and Illustrations of Exotic Lepidoptera.* By A. G. Butler, F.L.S., &c. (London: E. W. Janson.)

MR. BUTLER, who is well known as an ardent and careful student of the diurnal Lepidoptera, has undertaken, in conjunction with Mr. Janson as publisher, what will no doubt prove a very valuable and beautiful work. Many new species of Lepidoptera have been described—by Mr. Butler himself amongst others—without any figure: this practice is exceedingly inconvenient to those who attempt to identify species; and though, as Mr. Butler observes, it enables those who adopt it to "call the beautiful their own" to a larger extent than if they had to wait for figures, it is nevertheless a reprehensible proceeding, and has afflicted the conscience of one at least who has been guilty of it. Mr. Butler is a very skilful artist, and evidently an intense admirer of the lovely colours and forms of the insects he deals with. Consequently it is a matter for congratulation that he has undertaken to make up for the shortcomings of past times, and intends to bring out once a quarter a part of his "Lepidoptera Exotica," with three coloured plates of new or unfigured species. In the two parts already issued, which are before us, the figures are admirably done, and very handsome; whilst the descriptive text is concise, and in Latin in part. Some of Mr. Wallace's Bornean butterflies are figured in the second part. E. R. L.

Physiology of the Human Voice.—*Physiologie und Pathologie der Menschlichen Stimme.* By Dr. M. J. Rossbach. (Würzburg. London: Williams & Norgate.)

A TREATISE on the physiology of the voice, intended by the author to be useful not only to physiologists and pathologists, but also to those engaged in singing or in teaching singing. A chapter on the nature and qualities of sounds, based on Helmholtz' well-known work, and a short one on musical instruments, introduce the main topic, the physiology of the human organ of voice. There are also separate chapters on the vocal register, the different kinds of voice, and the relations of voice, speech, and song.

The Convolutions of the Brain.—*Die Hirnwindungen des Menschen.* By Alex. Ecker, Professor of Anatomy in the University of Freiburg. (Brunswick, 1869. London: Williams and Norgate.)

A SUCCINCT but detailed description of the various Convolutions of the Brain, intended chiefly for the use of physicians. It is illustrated by half-a-dozen outline sketches. The references to the development of the convolutions are not very full, but the author promises a more complete account elsewhere.

The Absolute Value of Knowledge.—*Der Sebständige Werth des Wissens.* By Prof. K. Rokitansky. (London: Williams and Norgate.)

THE Materialist school of philosophy are just now getting very badly treated by men of science, much to the astonishment, it appears, of the general public. Mr. Huxley has startled the world by proclaiming himself in a way a disciple of Berkeley and Kant, and here is Rokitansky, the great master of modern pathological anatomy, walking in a similar path. To many minds pathological anatomy would seem to be intensely materialistic. It is not so, however, to the Viennese professor. This little lecture is chiefly devoted to a development of idealism: of that kind of idealism, moreover, which "makes the objective wholly and in every way dependent on the subjective, for the former is but the projection of the latter."

Tables of Pomona.—*Tafeln der Pomona, mit Berucksichtigung der Storungen durch Jupiter, Saturn, und Mars.* By Dr. Otto Lesser. Publication der Astronomischen Gesellschaft. (Leipzig: Engelmann.)

THESE tables of Pomona are founded on the disturbance of the planets Jupiter, Saturn, and Mars, calculated according to Hansen's method, and published by the author in Nos. 1596–7 of the *Astronomische Nachrichten.* The preface gives a full account of the character of the tables, illustrated in the usual manner by the calculation of the place of the planet Pomona for a given time.

Although it might seem that the construction of a series of tables as full and as elaborate as Bouvard's Tables of Jupiter and Saturn, would be a waste of labour in the case of a minute planet like Pomona, not merely invisible to the naked eye, but not appreciably affecting by its influence any of the great planets of our scheme, yet this is not in reality the case. Though Pomona cannot affect the other planets, yet these affect Pomona. Her sister orb, Themis, has lately been made the means of affording a useful estimate of Jupiter's mass, through the careful consideration of the perturbations which that planet exerts upon the tiny asteroid. Long since Nicolai applied the perturbations of Juno, Encke those of Vesta, Gauss those of Pallas, and Brünnon those of Iris, to the same end. The more such researches are multiplied, the more exact will be our estimate of the mass of the principal planets of the solar system. Therefore, the present tables, by means of which it will be rendered an easy matter to estimate the disturbing action of Jupiter, will have a high value. In a less exact but not unsatisfactory manner, the mass of Mars may be estimated from the same tables, since in certain positions the disturbances of Pomona caused by Mars' attraction can be readily separated from those of Jupiter. R. A. P.

*SCIENCE-TEACHING IN SCHOOLS**

THE claims of Physical Science, on *à priori* grounds, to a fair place in the course of school work, have been abundantly vindicated, and are, I suppose, established. But the method and details of its teaching, the books and apparatus which it requires, and the amount of time which must be given to it, are points which can be decided only by experiment, and have not yet been decided at all. I cannot premise too distinctly that the aim of this paper is practical. Of the necessity for teaching science to their boys many good schoolmasters are convinced; as regards the machinery by which it is to be taught, they mostly confess their ignorance, and cry aloud for guidance. In my own school it has been taught systematically for the last five years, and I offer the fruit of this experience, very humbly, to all who are interested in Education.

The subjects to be taught—the time to be spent upon them—the books and apparatus necessary—and the mode of obtaining teachers—are the points on which information seems to be required. I will take them in order.

The subjects which naturally suggest themselves as most essential are Experimental Mechanics, Chemistry, and Physiology. But it has been urged by high authority, familiar to the members of this Association, that between Chemistry and Physiology Systematic Botany should be interposed, as well because of the charm this science lends to daily life, as from its cultivating peculiarly the habit of observation, and illustrating a class of natural objects which are touched indirectly or not at all by the other sciences named. Whether all these four subjects can be taught depends upon the period to which school education is protracted; but at any rate, let these, and none but these, employ the hours assigned especially to Physical Science, in the scheme of actual work in school. Abundant opportunity will remain for less direct instruction in many other branches of science. The Geographical lectures, if properly treated, will include the formation of the earth's crust, with the classification and distribution of its inhabitants, both animal and vegetable, both extinct and recent. The possession of meteorological instruments, whose observations are regularly taken, and their computations worked by the boys, will almost insensibly teach the principles of atmospheric phenomena; while such books as Maury's "Physical Geography of the Sea," Airy's "Popular Astronomy," and Herschel's "Meteorology," may be given as special matter for annual scientific prizes. The laws of light and heat will be taught as prefatory to chemistry. Electricity attracts boys so readily that with very little help they will make great progress in it by themselves. The mathematical master, whose best boys are well advanced, will not be satisfied till he has obtained a transit instrument and a mural circle. And the wise teacher, living in the country, will not disdain to encourage a knowledge of natural history. He will know that it is not only ancillary to severer scientific study, but in itself a priceless and inexhaustible resource. By country walks, by well-chosen holiday tasks, by frequent exhibitions of his microscope, he will not only add to the intellectual stock of his boys, but will build up safeguards to their moral purity. Indeed, even without such encouragement, boys who are trained thoroughly in certain sciences will of their own accord seek to become acquainted with other and collateral ones. Cases multiply in my own experience where pupils of a chemistry class have taken up electricity, pupils of a geography class mineralogy, pupils of a physiology class microscopy, and I need hardly say that boys make nothing their own so thoroughly as that which they select themselves.

The time to be given to science should not be less than three hours a week. At this rate two years may be given to mechanics, two years to chemistry, one year to botany; while the rest, if any remain, will be free for physiology. We need not be afraid of beginning early. A boy of eleven years old, fresh from an intelligent home, where his love of observation has been fostered, and his inquiries have been carefully answered, is far more fit to appreciate natural laws than a much older boy, round whose intellect, at an old-fashioned school, the shades of the prison house have steadily begun to close. Most schools are now divided into lower, middle, and upper. I would commence the study of mechanics with the junior class in the middle

* A Paper read before the British Association at Exeter, by the Rev. W. Tuckwell. Communicated by the Author.

school. For the first year the teaching may be *viva voce*, with easy problems and abundant experiment; care being taken that each week's lectures shall be reproduced on paper, and great attention being paid to correct drawing. In the second year the teaching will be more minute and more extended, and a good book will be mastered. At the end of this time the class is fit to pass creditably the Oxford Local Examination for juniors, and has done with mechanics for the present. The third and fourth years will be given to inorganic chemistry. The third year will include only lectures in the class room; a text-book being used, experiments being shown by the master, but no laboratory work being done by the boys. The fourth year's work will be conducted entirely in the laboratory, each boy manipulating with his own instruments at his own table. At the expiration of these two years the class will be qualified for the chemistry examination in the London University Matriculation. The fifth year is given to botany. If a good book is used, if each boy works for himself with lens and knife, if Henslow's Schedules, or a modification of them, are regularly filled up; above all, if plates are not made to do the work of living plants, the pupils will at the year's end thoroughly understand the principles of classification, will know the characteristics of at least all the British orders, and will be able with the help of Bentham or Babington to make out almost any English flower. The boys who have completed this course will be from 16 to 17 years old. Some of them will now be leaving school; those who remain will give the rest of their time to physiology. They will begin with human and will pass to comparative physiology, using in the first Professor Huxley's valuable little book; dependent for the second, of which no school manual exists, on the skill and method of their teacher. But whether at the earlier or the later age, they will pass out into the world immeasurably superior to their contemporaries who know not science, with doors of knowledge opened which can never again be closed; with a fund of resource established which can never be exhausted; with minds in which are cultivated, as nothing else can cultivate them, the priceless habits of observation, of reasoning on external phenomena, of classification, arrangement, method, judgment.

The subject of books and apparatus, involving as it does the question of expense, is of the highest practical importance. Apparatus need not cost much; but it may, and if possible it should, cost a great deal. While poor and struggling schools may begin cheaply and proceed gradually, institutions which can spend money on racket courts and gymnasiums ought not to grudge it on museums and botanic gardens. We have taught mechanics efficiently, that is to say, we have passed our classes for the last three years in the Oxford Local, with a good air-pump, a set of pulleys, models of the force-pump and the common pump, with Keith Johnston's scientific maps, and with the diligent use during the second year of Newth's "Natural Philosophy." But we have lost no opportunity of making the boys acquainted with machinery; from the crane and the water-mill of our daily walks, to the steam engine and the spinning jenny of the manufactory; for he who has not examined engines at work will never understand them clearly, or describe them correctly. For teaching chemistry, a laboratory is absolutely essential. No matter how rough or shabby a room, so that it be well ventilated, have gas and water laid on, and will hold from sixteen to twenty boys. I hold in my hand the model of a cheap laboratory table, on the scale of two inches to a foot. It is about nine feet by three, and contains eight compartments, each two feet by sixteen inches, with two slight shelves, and a special recess for the teacher. It costs about 4*l*. If made for twice the number of boys, it may be made at about nine shillings per boy. The general laboratory stock, including a still, a stove or furnace, gas jars, a pneumatic trough, a proper stock of retorts, crucibles, tubing, &c., and the necessary chemicals will cost under 12*l*. Each pair of pupils must have also between them a set of test tubes, a washbottle, a spirit lamp, a waste basin beneath their table, and twenty-four bottles of test solutions, while each boy has his own blowpipe, tripod and stand, pestle and mortar, and three beakers. These will cost each boy about eight shillings. He will replace everything that he breaks, and will receive the value of his stock from his successor when he quits the class. The text-book used should be Roscoe's, or Williamson's, and a large black board is quite indispensable. In botany the book for the boys' use is Professor Oliver's Lessons; but the teacher will find great advantage from Le Maout's "Leçons de Botanie." An excellent modification of Henslow's Schedule is published by Professor Babington for the use of his Cambridge classes, and Lindley's "Descriptive Botany," price one shilling, is a most useful help. Every boy should be furnished with a small deal board, a lens, and a sharp knife. The botanical microscope which I exhibit, including a lens fixed or movable, a black glass stage, two dissecting needles and a forceps, is made by Mr. Highley, of Green-street, Leicester-square. If they are ordered by the dozen he will furnish them at six shillings each. Flower trays, such as I hold in my hand, should be kept constantly in use; the boys being encouraged to bring in wild flowers, and to place them in their appropriate niches. Their cost per tray, holding eighteen bottles, is under two shillings. Fitch's diagrams designed for the Committee of Council on Education, which cost 2*l*. 9*s*. the set, are a valuable help to the lectures; and for schools which have large purses or liberal friends, Dr. Auzoux's Models of Plants and Plant Organs, ranging in price from 20 to 100 francs, and ten times the size of life, form a luxuriant assistance to beginners, which only those can appreciate who have worn out their eyesight and their temper over a composite floret or the glume of a small grass. The same excellent modellist, whose catalogue is on the table, provides every organ necessary for the study of comparative and human physiology; and his prices ought not to be beyond the reach of any prosperous school. In any case a skeleton will be necessary, and will cost about £5; and if the Committee of Council were to authorise the reproduction of such typical physiological cases as, from the skilful hands of Mr. Charles Robertson of the Oxford Museum, drew so many admirers in the Exhibition of 1862, these would find immediate purchasers in many of our schools. At present teachers want the skill or the leisure to make their own preparations, and they cannot buy them. A good set of meteorological instruments costs from £16 to £20, but these, with astronomical apparatus, are a costly luxury, and may be left out of the list of indispensable necessities. I cannot think that any school, professing to teach science systematically, will be long satisfied without a typical museum. As scientific work proceeds, specimens of all kinds, some purchased for lecture work, others given by friends or collected by the boys, will gather and increase, till the class-room cupboards and shelves are choked, and a special room must be devoted to them. Here will be arranged, in one place rocks and fossils, in another trays of minerals, in a third zoological specimens, in a fourth physiological preparations. The driest corner in the room will be assigned to the Herbarium, a small library of scientific reference will give promise of the future. Everything not typical will be rigorously excluded; every case will be so carefully arranged and so plainly labelled as to tell the history of its contents to the eye of the least instructed observer. And it will be hard if some corner of the playground cannot be laid out as a botanic garden. In the crowded school premises which we are happily leaving I have found room for nearly four hundred plants, and at the new school to which we are about to migrate, I shall riot in two acres of garden ground, with a pond for water plants and a sheltered rockery for ferns.

It remains only to examine the mode of obtaining teaching power; a point which presses heavily on many head-masters who have themselves no knowledge of science. That all head-masters should have such knowledge is a fact which, if science is to be taught at all, trustees and governing bodies must come to recognise before long: meanwhile every school which teaches science thoroughly is training skilled teachers for a not distant generation. Institutions which can give so high a salary as to command a London bachelor of science or a first class Oxford or Cambridge man, will find no more difficulty than attends the choice of all masters: where this is not the case it is sometimes possible by combining mathematics with physical science to tempt a superior man with a sufficient income; and, if only a small salary can be given, the ordinary pass B.A. of the London University will sometimes make a fairly good teacher. But one point has struck me forcibly in my own experience; namely, the unexpected value of general culture in teaching special subjects. The man who knows science admirably, but knows nothing else, prepares boys well for an examination; but his teaching does not stick. The man of wide culture and refinement brings fewer pupils up to a given mark within a given time: but what he has taught remains with them; they never forget or fall back. I am not sure that I understand the phenomenon, but I have noted it repeatedly.

I cannot end this paper without a word as to the educational results which our five years' experience has revealed. The system has brought about this result first of all, that there are no dunces in the school. In a purely classical school, for every promising scholar there are probably two who make indifferent progress, and one who makes no progress at all; and a certain proportion of the school, habitually disheartened, loses the greatest boon which school can give, namely, the habit and the desire of intellectual improvement. By giving importance to abstract and physical science, we at once redress the balance. Every boy progresses in his own subject; some progress in all; no one is depressed, no one thinks learning hateful. Secondly, the teaching of science makes school-work pleasant. The boy's evident enjoyment of the scientific lesson rouses the emulation of other masters. They discover that the teaching of languages may become as interesting as the teaching of science. They realise—a point not often realised—the maxim of Socrates, that no real instruction can be bestowed on learners "παρὰ τοῦ μὴ ἀρέσκοντος, by a teacher who does not give them pleasure." Lastly, the effect on the boy's character is beyond all dispute. It kindles some minds which nothing else could reach at all. It awakes in all minds faculties which would otherwise have continued dormant. It changes, to an extent which we cannot over-estimate, the whole force and character of school-life both to the learner and the teacher. It establishes, as matter of experience, what has long been urged in theory, that the widest culture is the noblest culture; that universality and thoroughness may go together; that the system which confines itself to a single branch of knowledge, does not gain, but loses incomparably, by its exclusiveness: that observation, imagination, and reasoning may all be trained alike; that we may, and so we must, teach many things, and teach them well.

W. TUCKWELL

THE LATE PROFESSOR GRAHAM

At 9 o'clock in the evening of Thursday, the 16th September, 1869, died at his house, No. 4, Gordon Square, a man whose name will be honoured as long as true greatness is appreciated.

Thomas Graham spent his life in reading the book of Nature, and giving to mankind a knowledge of the truths which he found there. His greatness is to be measured not merely by the amount and importance of the knowledge which he thus gave, but even more by the singleness and strength of purpose with which he devoted his whole life to labours of experimental philosophy.

Some men have made important discoveries by occasionally applying to experimental investigation, powers of mind which they exerted usually in the pursuit of their own worldly advancement.

But from an early age Graham's one great object of life was the discovery of new truths, and he appreciated so fully the value of such work that he resolved to make any personal sacrifices which might be needed for its sake. And nobly he kept his resolution; for at an early stage of his career he endured, for the sake of pursuing chemistry, privations and sufferings so severe, that they are believed to have permanently injured his constitution; and at its very end, long after he had attained a world-wide reputation, when his delicate frame sorely needed the repose which was at his command, he continued to labour even more effectively than before, and to enrich science with new discoveries.

It might be difficult to find in history a character so perfect in its noble simplicity and elevation.

Graham was born at Glasgow, on the 21st December, 1805, the eldest of a family of seven, of whom only one survives.

He went to the English preparatory school at Glasgow, in 1811, and was there under the care of Dr. Angus. In the year 1814 he was removed to the High School, where for four years his studies (which included the Latin language) were directed by Dr. Dymock, and subsequently for one year by the Rector, Dr. Chrystal, under whom he studied Greek. It is said that during these five years he was not once absent at school-time. In 1819 he commenced attendance in the University classes in Glasgow.

Thomas Thomson then occupied the Chair of Chemistry, and young Graham benefited by his instruction, as also by that of Dr. Meikleham, the Professor of Natural Philosophy.

By this time he had already acquired a strong taste for experimental science, and formed a wish to devote himself to chemistry. His father, an able and successful manufacturer, had formed different views for his future career, and wished him to become a minister of the Scotch Church. It is hardly to be wondered at that the father should not have seen in the prosecution of science much scope for an honourable or advantageous career; but young Graham had already seen something of the means afforded by experimental science of getting knowledge from the fountain head—from Nature herself. He felt the need of more such knowledge to mankind, and his scheme of life was formed accordingly.

After taking the degree of M.A. at Glasgow, he continued his studies for two years at Edinburgh, and there studied under Dr. Hope, and enjoyed the friendship of Prof. Leslie. On his return to Glasgow, he taught mathematics for some time at the suggestion and under the patronage of Dr. Meikleham, and subsequently opened a laboratory in Portland Street, Glasgow, where he taught chemistry. It is probable that some of the severest trials of his life occurred at about this period.

While absent from Glasgow he was in the habit of writing regularly and at great length to his mother, and from the tenor of these letters it is easy to see what that mother must have been to him. A writer on the social position of women has described the feelings of boys towards their mothers as scarcely amounting to respect! Young Graham's mother seems to have been his guardian angel, sympathising with his hopes and his sorrows; and certainly his feelings towards her would have been very inadequately described by that frigid word. While studying at Edinburgh he earned, for the first time in his life, some money by literary work, and the whole sum (6*l.*) was expended in presents to his mother and sisters.

In 1829 he was appointed lecturer on Chemistry at the Mechanics' Institution, Glasgow, in place of Dr. Clark; but the decisive step of his life was in the subsequent year. It was in 1830 that he was appointed Professor of Chemistry at the Andersonian University, Glasgow; and it is said that his mother, who was on her deathbed, lived to hear the glad tidings of his appointment. He was now more favourably circumstanced for experimental labours, and we find that the seven years spent at the Andersonian University were years of great activity.

In 1837 he was appointed Professor of Chemistry in the London University, now called University College, London, and he occupied that chair with great distinction till the year 1855, when he succeeded Sir John Herschel as Master of the Mint, which appointment may be considered an acknowledgment on the part of the Government of his scientific services and of his high character.

His numerous discoveries have been much quoted. Some of their theoretical bearings claim a brief notice here.

His investigation of the phosphates is remarkable in many ways. It was known that solutions of phosphoric acid in water vary in their properties; and chemists were satisfied with giving a name to the changes without investigating their nature. These solutions contained phosphoric acid and water, and were assumed to have like composition. They were accordingly called isomeric. Graham observed that they differ from one another in the proportion of water combined with the acid, and constitute in reality different compounds.

He knew that water combines with acids as other bases do, and he showed that the various compounds of phosphoric acid and water constitute distinct salts, each of which admits of its hydrogen being replaced by other metals without disturbance of what we should now call the type. Thus, to use our present notation, the three hydrates PO_4H_3, $P_2O_7H_4$, PO_3H, correspond to the following proportions of acid and water:—

$$P_2O_5 + 3H_2O = 2PO_4H_3$$
$$P_2O_5 + 2H_2O = P_2O_7H_4$$
$$P_2O_5 + H_2O = 2PO_3H$$

THOMAS GRAHAM (from a recent Photograph)

Graham observed that the hydrate PO_4H_3 is constituted like a salt, inasmuch as its hydrogen can be replaced atom for atom by other metals, like sodium, potassium, &c., forming such compounds as PO_4NaH_2, PO_4Na_2H, &c.

In order to appreciate duly the powers of mind of the author of this admirable research, we ought to compare his methods of reasoning with those generally prevalent among contemporary chemists, and on the other hand with the methods of to-day. One would fancy that Graham had been acquainted with the modern doctrines of types and of polybasic acids, so clearly does he describe the chemical changes in matter-of-fact language, and so consistently does he classify the compounds by their analogies. At that early period we find Graham considering hydrogen, in various salts, as a basylous metal; an idea which (in spite of its undeniable truth) some chemists of the present day have not fully realised.

Amongst minor chemical researches may be mentioned a series of experiments on the slow oxidation of phosphorus by atmospheric air. He discovered that this process (and the faint light which accompanies it) is arrested by the presence in the air of a trace of olefiant gas, $\frac{1}{450}$ of the volume of the air being sufficient for the purpose. Still smaller proportions of some other vapours were found capable of producing this same effect; spirits of turpentine being particularly remarkable, as less than a quarter of a thousandth of its vapour with air was found sufficient to prevent the slow oxidation of phosphorus.

On another occasion Graham investigated phosphuretted hydrogen, and made some remarkable observations concerning the conditions of the formation of the spontaneously inflammable gas. One of these deserves especial notice in connection with the action of olefiant gas, and in preventing the oxidation of phosphorus. He found that phosphuretted hydrogen is rendered spontaneously inflammable by the admixture of a very small proportion of an oxide of nitrogen, probably nitrous acid.

One of the most obscure classes of combinations are those which water forms with various salts. These bodies are characterised by the chief peculiarities which belong to definite chemical compounds; but chemists are as yet unable to explain them.

Water so combined is called water of crystallisation, and is said to be physically, not chemically, combined. A very convenient way of getting rid of a difficulty, by passing it on to our neighbours.

Graham examined the proportion of such water of crystallisation in a considerable number of salts, and he moreover examined the properties which it has when so combined. He found that some of the water in an important class of sulphates is held far more firmly than the remainder, and with force equal to that with which water is held in various chemical compounds. He showed that such firmly combined water can be replaced by salts in a definite chemical proportion. In fact, he got fairly hold of the subject by chemical methods, and laid the foundation for an explanation of it.

He discovered and examined compounds of alcohol with salts, and derived from them valuable evidence of the analogy between alcohol and water.

On a later occasion he made a series of important experiments upon the transformation of alcohol into ether and water, by the action of hydric sulphate. Liebig had endeavoured to explain the formation of ether in this process, by representing it as due to the decomposition at a high temperature of a compound of ether previously formed at a lower temperature; such decomposition being due to the increased tension of the vapour of ether at the higher temperature.

Graham justly argued that if the decomposition were due to the tension of ether vapour, it would not take place, and ether would not be formed, if the tension were not allowed to exert itself. He heated the materials in a closed tube, and proved that ether was formed, although the tension of its vapour was counteracted by the pressure thus obtained.

The line of research which occupied most of his attention, and in which his results were perhaps the most important, was that of diffusion; and it would be difficult to over-estimate the importance to molecular chemistry of his measurements, of the relative velocities of these spontaneous motions of particles of matter, whether in the state of gas or in the liquid state.

It was known that 1 part by weight of hydrogen occupies the same volume as 16 parts by weight of oxygen when measured at like temperature, and under like pressure. Chemical investigations prove that these equal volumes of the two gases contain the same number of atoms. We also know that the atoms in such a gas are in rapid motion, and resist the pressure to which the gas is at any particular time exposed, by striking against the surface which presses them together with force equal to that which presses them together.

Thus a given volume of hydrogen is maintained against the atmospheric pressure by an energy of atomic motion, equal to that of the same volume of oxygen. Each atom of hydrogen accordingly exerts a mechanical energy equal to that of each atom of oxygen; but we have seen that the hydrogen atom is much lighter than the oxygen atom, and accordingly it must move with much greater velocity than the oxygen atom.

Now Graham allowed hydrogen to escape through a very small hole in a plate of platinum; and allowed oxygen to escape under similar circumstances. He found that each hydrogen atom moves out four times as fast as each oxygen atom. His experiments were so arranged as to enable him to measure the relative velocities of certain motions of the atoms—motions not imparted to them by any peculiar or unnatural conditions, but belonging to them of necessity in their natural state. He found, moreover, that heat increases the velocity of these atomic motions, whilst increasing the force with which a given weight of the gas resists the atmospheric pressure.

The study of the condensation of gases by solids, and the combination of soluble compounds with membranes led him to discoveries which are likely to be of great value to physiologists in explaining processes of absorption and secretion.

Thus he found that oxygen is absorbed to a greater extent than nitrogen by caoutchouc, and that when a bag made of a thin membrane of this substance is exhausted by means of a good air-pump, the oxygen and nitrogen diffuse through it (probably as condensed liquids), and evaporate inside the bag in different proportions from those in which they are present in air; the oxygen rising to over 40 per cent. of the diffused air. Again, a mixture of hydrogen and oxygen was separated almost completely by the action of palladium, which condensed the hydrogen in very large quantity, and the oxygen very slightly.

Perhaps the most remarkable substances discovered in the course of his experiments on diffusion, were the soluble modifications of tungstic and molybdic acids, ferric oxide, &c., and the process by which these bodies were obtained was, perhaps, the most instructive part of the result; proving, as it does, that in their salts, these bodies have properties different from those which they normally possess in the free state; and retain them when the other constituent is removed by a sufficiently gentle process.

Another remarkable fact which bears on a most important theory, is the separation effected by Graham of potassic hydrate and hydric sulphate, by diffusion of potassic sulphate in aqueous solution—a fact which requires us to admit that the solution of the salt in water contains those products mixed with one another; just as much as the experiment of diffusing air through a porous clay pipe, and getting its constituent in a different proportion from that of the original air, proved that air is a mixture and not a compound of the two gases.

In his later researches Graham was assisted by Mr. W. C. Roberts, and cordially acknowledged the zeal and efficiency displayed by that able young chemist. Graham's scientific influence extended beyond his researches; for, on the one hand, his lectures for 18 years at University College were remarkable for logical accuracy and clearness of exposition, and were highly valued by those who had the privilege of hearing them. On the other hand, his "Elements of Chemistry" is a masterly exposition of the best known facts of the science and of chemical physics. It was translated into German, and afforded at that time the most philosophical account of the working and theory of the galvanic battery.

In many of his ideas Graham was in advance of his contemporaries, and it might be difficult to find a chemist who has dealt more cautiously with general questions and delicate experimental operations,—or one whose results, in each direction in which he has worked, may more safely be expected to stand the test of future investigations.

A. W. WILLIAMSON

THE MEETING OF GERMAN NATURALISTS AND PHYSICIANS AT INNSBRUCK, TYROL

FROM the 18th to the 24th of September last the little town of Innsbruck wore an air of unwonted bustle and excitement. Its population, already augmented by the usual throng of summer tourists, was swelled by the advent of somewhere about 800 additional visitors—professors, doctors, directors, men of all sciences, often with their wives and daughters, who had come from all parts of Germany to attend the forty-third Meeting of the German Naturalists and Physicians. These meetings resemble those of our own British Association, though they differ in several very characteristic respects. One of the first contrasts to strike an Englishman is the entire absence of private hospitality. Everybody, so far as we can learn, is in private lodgings or in a hotel; and there are no such things as dinner-parties. Although our own customs in these respects are certainly very pleasant, there can be no doubt that the German fashion leaves the visitors more freedom, and allows them much more opportunity of seeing and talking with the friends they most wish to meet. With us it is no easy matter to get together a party of chemists, or geologists, or physiologists, to hold a social gathering after the labours of the sections are over. We are all either staying with friends, or invited to dinner, or engaged in some way. But at the German meetings such social reunions are one of the distinguishing features. One o'clock in the day brings with it the necessity for dining, and numerous dinner parties are improvised there and then; friends of like tastes, who have not met perhaps for a year before, adjourn to a *restauration* or *kaffee-haus*, and while eating the meal have a pleasant opportunity of comparing notes, and discussing questions which have in the interval arisen.

Another feature of contrast is in the length of time devoted to the sitting of the sections. At the British Association the sections open their sittings at eleven in the forenoon; and the work goes on steadily all day without intermission till four or five o'clock in the afternoon. But, in Germany, the sittings commence sometimes as early as 8 A.M., and are frequently over by ten or eleven o'clock, leaving the rest of the day for some short after-dinner excursion, or for general miscellaneous intercourse among the members. In fact, the German meetings are designed less for the purpose of bringing forward new scientific work, than with the view of affording to men of science opportunities of becoming personally acquainted with each other, and of discussing the value and bearing of recent contributions to knowledge. Hence, the papers which are brought before the sections, contain, to a large extent, outlines, summaries or notices of recent researches, and exhibitions of books, maps, memoirs, specimens, experiments, &c., which have recently attracted notice.

In our British Association gatherings, there is probably more hard work than in those of our German brethren, and I daresay there is as much opportunity for sociality as suits our national temperament. For our Association is meant, not merely to promote a friendly intercourse among scientific men, but to be a kind of propagandist for the advancement of science through the general community. So we make a compromise between sober, serious, hard work for science on the one hand, and unrestrained festivities on the other. The German meetings keep less prominently before them the scientific culture of the world outside, and aim rather at the strengthening of the hands of the individual worker.

From the papers read at the different sections; from the discussion which they elicited; and still more perhaps from the public addresses on subjects of general interest given to the whole assembled meeting; one could gather some suggestive traits of the present current of thought in at least one great section of the cultivated society of Germany. What specially struck me was the universal sway which the writings of Darwin now exercise over the German mind. You see it on every side, in private conversation, in printed papers, in all the many sections into which such a meeting as that at Innsbruck divides. Darwin's name is often mentioned, and always with the profoundest veneration. But even where no allusion is specially made to him, nay, even more markedly, where such allusion is absent, we see how thoroughly his doctrines have permeated the scientific mind even in those departments of knowledge, which might seem at first sight to be furthest from natural history. "You are still discussing in England," said a German friend to me, "whether or not the theory of Darwin can be true. We have got a long way beyond that here. His theory is now our common starting point." And so, as far as my experience went, I found it.

But it is not merely in scientific circles that the influence of Darwin is felt and acknowledged. I do not think it is generally known in England, that three years ago, when, after the disastrous war with Prussia, the Austrian Parliament had assembled to deliberate on the reconsolidation of the empire, a distinguished member of the Upper Chamber, Professor Rokitansky, began a great speech, with this sentence:—"The question we have first to consider is, Is Charles Darwin right or no?" Such a query would no doubt raise a smile in our eminently unspeculative houses of legislature. But surely never was higher compliment paid to a naturalist. A great empire lay in its direst hour of distress, and the form and method of its reconstruction was proposed to be decided by the truth or error of the theory of Darwin. "The two men," said one able physician of Vienna to me (himself, by the way, a North-German), "who have most materially influenced German thought in this country are two Englishmen—George Combe and Charles Darwin."

There was another aspect of the tone of thought at Innsbruck, which could not but powerfully impress a Briton. Although we were assembled in the most ultra-Catholic province of Catholic Austria, there was the most unbridled freedom of expression on every subject.

In an address on recent scientific progress, Helmholtz thus expressed himself—"After centuries of stagnation physiology and medicine have entered upon a blooming development, and we may be proud that Germany has been especially the theatre of this progress—a distinction for which she is indebted to the fact that among us, more than elsewhere, there has prevailed a fearlessness as to the consequences of the wholly known Truth. There are also distinguished investigators in England and in France, who share in the full energy of the development of the sciences, but they must bow before the prejudices of society, and of the Church, and if they speak out openly, can do so only to the injury of their social influence. Germany has advanced more boldly. She has held the belief, which has never yet been belied, that the full Truth carried with it the cure for any injury or loss which may here and there result from partial knowledge. For this superiority she stands indebted to the stern and disinterested enthusiasm which, regardless alike of external advantages and of the opinions of society, has guided and animated her scientific men."

This liberty of expression, however, seemed sometimes apt to wear not a little the aspect of a mere wanton defiance of the popular creed. Yet it was always received with applause.

In an address on the recent progress of anthropology, Karl Vogt gave utterance to what in our country would be deemed profanity, such as no man, not even the most free-thinking, would venture publicly to express. Yet it was received, first with a burst of astonishment at its novelty and audacity, and then with cries of approval and much cheering. I listened for some voice of dissent, but could hear none. When the address, which was certainly very eloquent, came to an end, there arose such a prolonged thunder of applause as one never hears save after some favourite singer has just sung some well-known air. It was a true and hearty *encore*. Again and again the bravos were renewed, and not until some little time had elapsed could the next business of the meeting be taken up. Not far from where I was standing, sat a Franciscan monk, his tonsured head and pendent cowl being conspicuous among the black garments of the *savans*. He had come, I daresay, out of curiosity to hear what the naturalists had to say on a question that interested him. The language he heard could not but shock him, and the vociferation with which it was received must have furnished material for talk and reflection in the monastery.

ARCH. GEIKIE

TRIASSIC DINOSAURIA

It will probably interest geologists and palæontologists to know that a recent examination of the numerous remains of *Thecodontosauria* in the Bristol Museum, enables me to demonstrate that these Triassic reptiles belong to the order *Dinosauria*, and are closely allied to *Megalosaurus*. The vertebræ, humerus, and ilium, found in the Warwickshire Trias, which have been ascribed to *Labyrinthodon*, also belong to *Dinosauria*. The two skeletons obtained in the German Trias near Stuttgart, and described by Prof. Plieninger, some years ago, are also unquestionable *Dinosauria*; and, as Von Meyer is of opinion, probably belong to the genus *Teratosaurus*, from the same beds. Von Meyer's *Platæosaurus*, from the German Trias, is, plainly, as he has indicated it to be, a Dinosaurian.

As Prof. Cope has suggested, it is very probable that *Bathygnathus*, from the Triassic beds of Prince Edward's Island, is a Dinosaurian; and I have no hesitation in expressing the belief, that the *Deuterosaurus*, from the Ural, which occurs in beds which are called Permian, but which appear to be Triassic, is also a Dinosaurian. It is also very probable that *Rhopalodon*, which occurs in these rocks, belongs to the same order. If so, the close resemblance of the South African *Galesaurus* to *Rhopalodon*, would lead me to expect the former to prove a Dinosaur.

I have found an indubitable fragment of a Dinosaurian among some fossils, not long ago sent to me, from the reptiliferous beds of Central India, by Dr. Oldham, the Director of the Indian Geological Survey. Further, the determination of the Thecodonts as *Dinosauria*, leaves hardly any doubt that the little *Ankistrodon* from these Indian rocks, long since described by me, belongs to the same group.

But another discovery in the same batch of fossils from India, leaves no question on my mind that the Fauna of the beds which yield Labyrinthodonts and Dicynodonts in that country, represents the terrestrial Fauna of the Trias of Europe. I find, in fact, numerous fragments of a crocodilian reptile, so closely allied to the *Belodon* of the German Trias, that the determination of the points of difference requires close attention, associated with a *Hyperodapedon*, larger than those discovered in the Elgin Sandstones, but otherwise very similar to it.

Thus, during the Triassic epoch, extensive dry land seems to have existed in North America, Western and Central Europe, Eastern Europe, Central India, and South Africa, as it does now; and, throughout this vast area, the *Dinosauria*—the links between reptiles and birds—seem to have been represented by not fewer, probably by many more, than nine or ten distinct genera.

I hope, shortly, to have the honour of placing the details of the researches into the structure and distribution of the *Dinosauria*, in which I have been engaged for the last two years, and of which the above notice is one of the results, before the Geological Society.

T. H. HUXLEY

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his Correspondents.*]

The Suez Canal

THE all-engrossing topic of the day is the Suez Canal, about which some diversities of opinion still exist. As for many years back I have had my attention particularly drawn to some of the chief matters in dispute, having been engaged on the largest irrigation works in India, I venture to trouble you with the following remarks.

Engineering science and indomitable energy have, in the case of the Suez Canal, overcome difficulties which at one time were considered insurmountable; but even up to the present moment doubts still exist, and some fear that the whole scheme may yet prove a failure, owing to the débris of the Nile travelling eastward transported by the currents of air and water. That we can overcome the former is, in my opinion, beyond all doubt; for it is found that whenever an irrigation channel is run out from the Jumna Canal into the great desert of Northern India, rich vegetation takes the place of arid sand. And so in Egypt will irrigation force back the desert; so the only question is, Can irrigation be carried out on an extensive scale? And of this also I have no doubt, for the enormous volume of water which now flows into the sea and is lost, is quite sufficient to reclaim the whole of the desert.

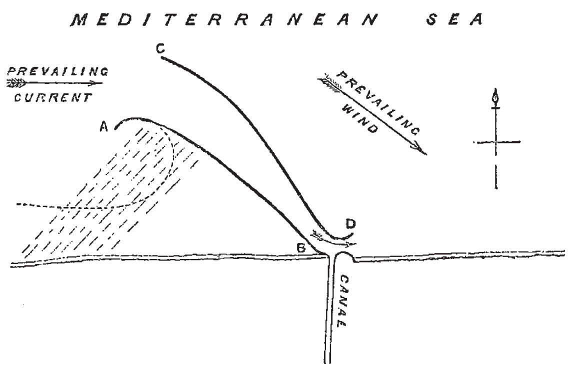
It may be asked, Can the water be made to flow over the desert? And of this I hold that there can also be no doubt. The very name of the Timsa Lake proves, I think, that the Nile, or at least a branch of it, flowed eastward, for the word *Timsa* signifies crocodile, showing that the water must at one time have been brackish or fresh, for these creatures could not have existed in this lake had it been salt as at present. If, therefore, a portion of the Nile water at one time flowed eastward, there can be no great engineering difficulty to make it do so again; and I am almost inclined to think that it would have been better to have made the canal a fresh-water one, for it is only by vegetation, the produce of irrigation, that the desert can be kept under control. Other advantages may be cited, such as cleaning the bottom of ships by bringing them into fresh water, and the prevention of any of the disturbed and very muddy waters along the Mediterranean coast getting admission into the canal; for by keeping the water in the canal at a higher level than that of the sea at both ends there could only be an outflow. So all the water wasted would be expended on lockage.

It may be objected that the fresh-water canal would get silted up by the muddy waters of the Nile; but could not this Timsa Lake be used as a silt-trap? I do not mean to say, that the present canal will be a failure because it has not been made a fresh-water one; but what I do think is, that possibly in the end a fresh-water canal would have been best and perhaps cheapest, as the dredging of the canal might have been much reduced,* as the water could have been kept at a higher level in the canal.

The great difficulty, however, to contend against, appears to me to be to keep a deep-water channel at the Mediterranean end of the Canal; and what drew my attention to this more than a dozen years ago, was the fact that the harbour of Alexandria does not get silted up. Some have supposed that the subsidence of the delta accounts for this, and that the small advance of the land on the sea in this direction is owing to a constant sinking of the land. In my opinion a very different cause can be assigned: Nature here is working by a very different agency, namely, the current in the Mediterranean which flows eastward all along the African coast, and transports the débris of the Nile, depositing it all along the western portion of the Mediterranean. The fact of the Timsa Lake being at one time fresh or brackish, goes to support this view; so the only question is, Will the cost of continuous dredging be so excessive that the Canal will become a financial failure? On this point I cannot venture to give an opinion, as I have no data, but I think this difficulty may be met by forcing this easterly current to aid in keeping the mouth of the Canal clear of silt deposits.

What aids this current to transport the earthy matter is the beat of the sea always stirring the mud and sand up on the coast, and enabling the water to hold a large proportion of matter in suspension, and even to transport heavy matter.*

The proportion of earthy matter a short distance out to sea is comparatively little, so the great object appears to me to prevent the agitated water travelling as it does at present, and this can be done by arranging the breakwaters somewhat as shown in this diagram.



The breakwater AB is intended to prevent the very muddy water travelling along the coast, and the point A should extend well out into deep water. The breakwater CD is to direct the comparatively pure water where the sea is deep to pass across the mouth of the canal; and by the funnel-mouthed shape thus given, the velocity at D will be increased, and thus keep deep water at the head of the canal. Some may say that the expense will be enormous, and that it will have to be year after year extended. But, in reply to this, I say that deltas do not extend out into the sea at so rapid a rate as some suppose; and that the formation of a delta takes several thousands of years to accomplish, so that in this very delta, the advance is hardly perceptible; and that a sinking of the land has been brought forward, to account for the very slow progress made; while, in fact, Nature has at present a power at work which is quite sufficient to explain the reason why so little advance is made on the sea during the historic period (see my paper on the Delta of the Irrawaddy, read before the Royal Society of Edinburgh in 1857).

In conclusion, I have no doubt this Suez Canal will have many ready to abuse it and say it is a total failure, as has been said of the Ganges Canal; but like the latter work, which last year saved some three million human beings from starvation, so will this canal, I have little doubt, outlive the abuse, and become one of the greatest blessings to the civilised world.

T. LOGIN, C.E., late of the Ganges Canal.

London, Oct. 29, 1869.

* I observe that, in a discussion at the Civil Engineers Institution, the total excavation of the Suez Canal is stated to be 70,000,000 cubic metres. The excavation of the Ganges Canal was 2,547,000,000 cubic feet, or a little over 70,000,000 metres; but this latter does not include some 3,000 miles of distribution channels.

* At Felixstowe, last March, during a gale of wind, I watched a mass of brickwork, some eighteen inches square and about six inches thick, moved along the coast by the action of the waves, which were in an oblique direction to the coast, and no doubt the same takes place along the mouths of the Nile. By a sample I took of this agitated water, I found it contained 0·7375 per cent. of its weight of small pebbles, sand, and mud. This sample was taken at a height of nearly ten feet above the sea, and was got by catching the spray of the sea as it was falling.

NOTES.

By offering Dr. Temple the Bishopric of Exeter, Mr. Gladstone has removed from his post the most eminent schoolmaster in England. Dr. Temple has done much for the education, present and future, of all classes; and although this is not the place to comment on all he has done in this direction, we may note here what he has done for education in Science. He may fairly claim to be the first head-master who has recognised its importance, and effectively introduced it into his school. And its introduction at Rugby is of special importance, because it is the acknowledged leader in educational progress, and because so many head-masters have been trained there. Now Harrow and Eton, and several other schools are doing something, though none yet with quite the same liberality as Rugby: but it will be instructive to look back ten years, and thus to estimate the advance. Rugby was then the only public school where science was taught at all. But even there it was under great disadvantages. No school was assigned to it; it was an extra, and heavily weighted by extra payment. There was no laboratory, scarcely any apparatus, and scarcely any funds for procuring it. About forty to fifty boys attended lectures on it, but there was no possibility of making those lectures consecutive, and of dealing with advanced pupils. Now there is a suite of rooms devoted to science. A large and excellent laboratory, where thirty boys are working at the same time at practical chemistry with the assistance of a laboratory superintendent, opens into a smaller private laboratory, which is for the use of the master and a few advanced students. This again opens into a chemical lecture room, in which from forty to fifty can conveniently sit. The seats are raised, and the lecture table fitted with all that is required. Adjoining is the physical science lecture room, in which sixty can sit, and of which a part is assigned to work tables. And out of this the master's private room is reached, in which apparatus is kept, and experiments and work prepared. There is a considerable geological museum, and an incipient botanical collection. A Natural History Society meets frequently, and publishes reports and papers contributed by the boys. Five masters take part in teaching natural science. It is introduced into the regular school work (about 360 out of 500 appear to be in the Natural Science classes); being compulsory on all the middle school; an alternative in the upper school; and optional in the Sixth Form. And the result of the teaching has been satisfactory. It has not damaged classics. It has been the means of educating many boys, and has been a visible gain to the great majority; and it has steadily contributed to the lists of honours gained at the University. If Dr. Temple had done nothing else, his name would deserve honour at our hand for having brought about this change. Let us hope that his successor will be equally liberal to science, and maintain its efficiency.

The public anxiety about the fate of our great explorer, Dr. Livingstone, has been anything but allayed by the recent telegrams from Bombay and Zanzibar, wanting, as they seem to do at present, the stamp of the approval of Sir R. Murchison. The Bombay mail is now hourly expected; and, by the opening meeting of the Royal Geographical Society, Sir Roderick will be in possession of all the data on which to form a complete estimate of the recent intelligence, and will then communicate the results. In the meantime, we wait and hope; Livingstone is not the man to do his work hastily or incompletely, or to return leaving anything unexplored.

The President of the Royal Society, Sir Edward Sabine, being unable, through pressure of official duty, to accept the Khédive's invitation to be present at the opening of the Suez Canal, was allowed to nominate a gentleman to represent the Royal Society on the memorable occasion. The President's choice, which has been approved by the Council, fell on Mr. J. F. Bateman, C.E. This selection will perhaps gratify the civil engineers as well as the Royal Society, for Mr. Bateman, who is now on his way to Egypt, has made himself known on the Mediterranean, by his land-reclamations in Majorca and at the mouth of the Ebro.

Drs. Carpenter and Wyville Thomson have just concluded a remarkably successful dredging expedition in the surveying ship *Porcupine*, the scientific results of which will shortly be laid before the Royal Society. They succeeded in bringing up large quantities of ooze from a depth of more than 2,400 fathoms, and have established the wonderful facts, that at such enormous depths, in total darkness, and with a temperature below the freezing-point, there is not merely life but life in abundance; not merely the lowest organisms, but highly developed Mollusca, Echinoderms, and Star-fishes. Many practical points of great importance for future investigation have been established during this cruise, more especially the proper mechanical arrangements by which dredging can be carried on in almost all weathers, thus enormously increasing the amount of work that can be performed in a given time; and, what is perhaps of equal value, the discovery by Captain Culver of a far more effectual method than the dredge for obtaining in large numbers many of the characteristic inhabitants of these profound ocean depths. Copious series of thermometric observations have also been taken, which point to results of great theoretical interest.

The "Female Physicians" question, thanks to Professor Masson, has made a great stride during the past week. Ladies are to be admitted to study Medicine at Edinburgh University. Imagine the feelings of the non-contents when Professor Masson, in a final outburst, described their argumentation as "rampageous mysticism, dashed with drivel from Anacreon!"

We are glad to learn that, through the generosity of a friend of science who forbids the mention of his name, the publication of the *Astronomical Journal* is about to be resumed. Dr. Gould will edit it, as before.

The Fellows of the Chemical Society reassemble this evening (Thursday), and begin the work of the session by discussing the President's elaborate paper on the Atomic Theory, which has been printed at length in the Journal of the Society. Any contribution to chemical philosophy from the pen of Professor Williamson must command the attention of those who have studied the history of chemistry, and the discussion he has invoked will doubtless be sustained by able supporters and opponents. Prof. Williamson holds that the atomic theory is the consistent general expression of all the best known and best arranged facts of chemistry, and he challenges detractors to bring forward an alternative theory. He asserts that all chemists use the atomic theory, though many refer to it as something which they would be glad to dispense with; and that all the facts which point so distinctly to the existence of molecules derive their significance from the atomic theory. Even those who cannot accept Dr. Williamson's conclusion that the atomic theory is the very life of chemistry, will doubtless feel duly grateful for his masterly summary of the evidence by which the theory is upheld.

We learn with regret from *Trübner's Literary Record* that the Imperial College of Pekin, which was established to disseminate the knowledge of the West amongst the Celestials, appears to have ended in a failure. Prince Kung favoured it, but other powerful Mandarins, and amongst them Wo-Jen, a leader of the anti-foreign party, have succeeded in extinguishing it. We are afraid that we have here the result of Occidental diplomacy. Has Wo-Jen been tampered with by Lowe-king?

It should make Englishman sad to think that while Mr. Peabody, who we trust is now better, finds the most pressing call here on his far more than princely munificence, to be the cry of the poor to heaven for bread and fresh air, in his own country, he finds the progress of Science alone needing his fostering aid. We have before us the first annual report of the Trustees of the *Peabody Academy of Science*, giving a full account of the manner in which the gift of 140,000 dollars is to be expended or invested, and of the progress already made in the buildings, natural history collections, musuems, and published proceedings, which we trust will worthily carry down the name of Peabody to posterity.

M. LOUIS LACAZE has bequeathed to the French Academy of Sciences the funds necessary for the foundation of three prizes of 10,000 francs each, to be awarded every second year. The sciences for which these prizes are to be given are Physiology, Physics, and Chemistry.

WE understand that Mr. James Young intends founding in Glasgow an institution for the study of Technology, to be opened in the course of the ensuing year.

A FRENCH translation of Professor Huxley's Elementary Physiology is announced.

WE understand that the appointment of Master of the Mint has not yet been filled up.

EARTHQUAKES seem approaching inconveniently near us. On Sunday night and Monday morning severe shocks were felt at Frankfort, Darmstadt, Wiesbaden, and Mayence; while a succession of shocks on the night of October 2, seems to have been unpleasantly violent, as the following extract from a letter from Coblentz, with which we have been favoured, will show:—"The greatest event we have had lately was an *earthquake!* It was on the night of Saturday, October 2, a little before 12, when most people were in bed, and were startled out of their sleep. I was wide awake, luckily, so came in for the whole; the noise was most alarming, and when my bed shook under me I guessed what it was. People in the town ran into the streets, and there was general alarm, as the shocks were so severe. The worst was about ten miles off, where chimneys fell and some walls cracked, but everywhere the accompanying noise seems to have been very great, like a train running under the house in bumps and jerks. The whole extent of the earthquake was very considerable, and many said they had never felt so bad a one before."

HERE are some notes from Oxford:—

On the 28th ult., the Warden and Fellows of Merton College elected Professor Clifton, F.R.S. (as Professor of Experimental Philosophy) to a Fellowship in the College. This is, we believe, only the second time that a college has availed itself of the power given by its new statutes of electing a professor to a fellowship, the person so elected being unconnected with the college in question, either by past or present membership, or by his professorship. Instances have occurred of the election of Professors to Fellowships in the colleges to which their Professorships were attached, but in this case the authorities of Merton College, without the least pressure or solicitation from without, have acted up to their increased powers given them by the last statutes, although the professorship is attached to Wadham College. We hail this piece of news with the greatest pleasure, as it indicates the desire which is now beginning to show itself, to devote the funds represented by fellowships to the purposes of University work, rather than to treat fellowships as simple prizes. The triennial elections of members of Council of the University is an important event at Oxford, as that body has sole power of initiation in University matters. The following were elected as the result of the poll on Thursday last:—The Dean of Christ Church; the Presidents of Trinity and Magdalen; Professors Price, H. Smith, and Scott; Mr. Ince, of Exeter; Mr. Liddon, of Christ Church, and Mr. Fowler, of Lincoln. The deputy appointed by Sir Benjamin Brodie to deliver lectures for him this term is Mr. A. Vernon Harcourt, of Christ Church. There are nineteen "unattached students" among the Freshmen, unattached students being persons who have availed themselves of the recently granted privilege of becoming members of the University, without becoming members of any College. Mr. Lawson, the Professor of Botany and Rural Economy, will give a course of Lectures during the ensuing term on the minute anatomy of plants. They are to be delivered in the Herbarium at the Botanic Gardens every Tuesday and Friday at 8 P.M. Is this hour fixed as the one at which it is most likely that members of the University, interested in Botany, will attend? We well remember when Prof. Lindley lectured at University College, London, to audiences of from eighty to a hundred students at 8 A.M. An election to the Lee's Readership in Anatomy will be holden at Christ Church on Saturday, December 18. Candidates for the office are requested to apply for information to the Dean on or before Saturday, the 13th of November.

AND here is a note from Cambridge:—The Rev. T. G. Bonney, B.D., Tutor of St. John's, has been appointed Lecturer in Natural Science at Cambridge; and Mr. Trotter, of Trinity, will lecture on Electricity, Magnetism, and Botany. We understand that these arrangements have been made because the staff of university professors is not large enough to do all the teaching in Natural Science that is required. We congratulate the University on the increased desire for instruction in these subjects; but is the number of men in the University competent to teach them so small that it has been found necessary to entrust Electricity and Botany to the same lecturer?

ASTRONOMY

The Astronomical Congress at Vienna

THE German Astronomical Society, although it dates from only one or two years back, is already in earnest work, and this year a Congress, extending over several days, was held at Vienna, at which not only were the president and council elected for the next year, but many papers of astronomical importance were read. Count Marshall has been good enough to send us the following account of the meeting:—The Society numbers actually 209 members, most of them superintendents of German and Extra-German Observatories; about 50 met at Vienna, among whom MM. Struve, of Pulkowa (President), Möller (Sweden), Forster (Berlin), Scheibner (Leipzig), Hersch (Neufchâtel), Lieut.-Gen. Bager (Berlin), Prof. Schaub (Trieste), Prof. Julius Schmidt (Athens), Mr. Schönfeld (Mannheim), were perhaps the most eminent. On Sept. 13, the first day of meeting, M. Struve opened the session with an exposition of the purpose of the Society and the recent progress of astronomy, especially of the knowledge of the physical nature of celestial bodies. Since the last meeting at Bonn, the number of members, the pecuniary resources, and the library have notably increased, and the following publications have been issued: Two years of the Quarterly Periodical, Dr. Auwers's paper on Variable Proper Movements, Dr. Lesser's Tables of Pomona, and Dr. von Asten's new Tables of Reduction for the "Histoire céleste Française." The study of the Asteroids, new Tables of Jupiter and of Comets, especially of the periodical ones, are in active preparation. Prof. Auwers distributed copies of tables for the reduction of positions of fixed stars from 1750 up to 1840, prepared at the Observatory of Pulkowa; and gave an account of his own new reduction of Bradley's observations, undertaken by order of the same Observatory, and of his tour to England for this purpose, during which he found, at Oxford, a number of old and very complete observations of fixed stars. The President referred to his connection with the German North Polar expedition. Prof. Julius Schmidt exhibited and explained a map of the Moon 6 feet in diameter, made at the Observatory of Athens. Prof. Zöllner (of Leipzig) detailed his recent observations of the Sun on the Janssen-Lockyer method.

September 15.—Prof. Bruhns (Leipzig) commemorated the hundredth birthday of A. von Humboldt, and distributed the prospectus of a biography of this illustrious man of science, which he intends to publish. Forty new members were admitted. Prof. Zöllner continued his lecture on his observations of the solar protuberances, and on a method of ascertaining the movements of celestial bodies by means of spectral analysis. His views were discussed by MM. Oppolzer, Scheibner, and Struve. A number of proof-prints of Prof. Heis' (Münster) stellar maps were committed to MM. Julius Schmidt and Prof. Galle, to report upon. M. de Littrow, superintendent of the Vienna University Observatory, communicated and explained the plan of the new Observatory to be built there, and commented upon the recent endeavours of some calculators of the solar parallax to derive useful results from Father Hell's observations, dating from 1769, proving these attempts to be altogether useless, by exhibiting the original diaries of this observer, and distributing fac-similes of the most important passages of them. A communication, concerning the establishment of a Humboldt Foundation at Vienna, was read.

September 16.—The president and council were elected; M. Struve, President; Prof. Bruhns, Vice-President; MM. Auwers and Winnecke, secretaries; Prof. Zöllner, Librarian; M. Auerbach, Treasurer; MM. Argelander and de Littrow, members of the Council. A new member was admitted. Mr. Julius Schmidt read his report on Prof. Heis's stellar maps. Prof. Forster read a paper concerning the solar eclipse of August 18, 1868, with Dr. Tieb's remarks on the photograms of it, taken at Aden, and proposed that the President and Council should ensure their assistance on the occasion of the next transit of Venus to any astronomers who should apply for it. The motion has been adopted. Dr. Kaiser gave an account of his observations concerning the ellipsoidal form of the Moon, and the solar protuberances, which elicited a reply from Prof. Zöllner, M. de Littrow communicated the first report of the permanent Adriatic Commission, and the programme of the prizes for the discovery of comets, lately proposed by the Imperial Academy of Vienna. Prof. Schönfeld exhibited a letter from Fabricius to Tycho Brahe (1596), in which the first notice of Mira Ceti is given, and entered into historical details concerning this variable star. The session of 1869 was closed by thanks voted to the Imperial Academy for having placed suitable localities at the disposal of the Society.

CHEMISTRY

Preparation of Uranium

M. PELIGOT has communicated to the Annales de Chimie et de Physique [xvii. 368] a short note on the preparation of uranium. A mixture of 75 grammes of uranous chloride, 150 grammes of dry potassium chloride, and 50 grammes of sodium in fragments, is introduced into a porcelain crucible, itself surrounded by a plumbago crucible. The reaction is effected in a wind furnace, at the temperature of redness; but the heat must be increased for a short time at the close of the operation. In the black slag may be found, after cooling, globules of fused uranium. Throughout the operation, it is necessary to avoid the presence both of moisture and atmospheric air.

A specimen of the metal prepared in this way by M. Valenciennes had the specific gravity, 18·33. Uranium, is, therefore, one of the densest of metals.

Stannous Chloride and Acids of Arsenic

A. BETTENDORFF has examined the action of stannous chloride on the oxygen acids of arsenic. When a solution of stannous chloride in fuming hydrochloric acid is added to a solution of arsenious or arsenic oxide in the same acid, a brown precipitate is formed, which, after proper washing and drying, consists of metallic arsenic mixed with a small quantity of stannic oxide. In an aqueous solution of arsenious or arsenic acid, stannous chloride produces no precipitate; but on adding strong hydrochloric acid till the liquid fumes slightly, precipitation takes place. Arseniferous hydrochloric acid of sp. gr. 1·182 to 1·135 gives an immediate precipitate; the same diluted to sp. gr. 1·115 gives imperfect precipitation after some time; and in a similar solution of sp. gr. 1·100, no precipitation takes place. From this it may be inferred that the reaction occurs only between stannous chloride and arsenious chloride; further, that in a solution of arsenious acid in hydrochloric acid of sp. gr. 1·115 part of the arsenic is present as chloride, but that hydrochloric acid of sp. gr. 1·100 dissolves arsenious acid as such, without converting it into chloride. The reaction above described is extremely delicate, and capable of detecting 1 pt. of arsenic in a million parts of solution. On antimony compounds stannous chloride exerts no reducing action, even after prolonged heating: hence the above-described reaction may be used to detect the presence of arsenic in antimony compounds, the solution being previously saturated with hydrochloric acid gas. Another useful application of the same reaction is to the preparation of hydrochloric acid free from arsenic: 421 grms. of crude hydrochloric acid of sp. gr. 1·164 were mixed with a fuming solution of stannous chloride, the precipitate separated by filtration after twenty-four hours, and the hydrochloric acid distilled, the receiver being changed after the first tenth had passed over, and the remaining liquid distilled nearly to dryness. The acid thus obtained gave not the slightest indications of arsenic, either by Marsh's test or by precipitation with hydrogen sulphide.—[Zeitschr. f. Chem. (2), v. 492.]

Dichlorinated Aldehyde

PATERNO has obtained dichlorinated aldehyde $C_2H_2Cl_2O$ by the action of sulphuric acid on dichloracetal. It is a liquid boiling at 89°—90°, attracts moisture from the air, and is thereby converted into a hydrate, which crystallises in beautiful laminæ, Left to itself, even in sealed tubes, it becomes dense, and changes into a white amorphous mass, which has the aspect of porcelain; but, when heated to 120°, is reconverted into the original product. Dichlorinated aldehyde dissolves without decomposition in alcohol and ether; when poured into water, it first sinks to the bottom and then dissolves, especially on application of heat; in short, it exhibits the most complete analogy with chloral. It is difficult to oxidise, its vapour not undergoing any sensible alteration when mixed with air or oxygen and passed over red-hot spongy platinum; but when gently heated with several times its own volume of fuming nitric acid, it is energetically attacked and converted into *dichloracetic acid* $C_2H_2Cl_2O_2$. Phosphoric pentachloride attacks it strongly, producing the compound $C_4H_4Cl_6O$ or $C_2H_2Cl_2O \cdot C_2H_2Cl_4$, the action doubtless consisting in the replacement of O by Cl_2 (as in the action of PCl_5 on aldehydes in general), whereby $C_2H_2Cl_4$ is produced, which, as soon as it is formed, unites with a portion of the undecomposed dichlorinated aldehyde, producing the compound $C_4H_4Cl_6O$. The constitution of this body may be represented by the following formulæ:— $CHCl_2—CH_2—O—CCl_2—CHCl_2$,

or perhaps by $CHCl_2—CHCl—O—CHCl—CHCl_2$.

The compound $C_4H_4Cl_6O$ is a colourless oil, having an irritating odour, heavier than water, soluble in alcohol and ether; it distils at 250° emitting acid vapours. Alcoholic potash attacks it strongly, with evolution of heat, and formation of potassium chloride; and, on adding water to the resulting liquid, a heavy aromatic oil separates, boiling at 196°, and having the composition $C_4H_2Cl_4O$—that is to say, containing 2HCl less than the preceding. This last compound unites directly with four atoms of bromine, forming the crystalline compound $C_4H_2Cl_4Br_4O$. In this respect, the compound $C_4H_2Cl_4O$ is analogous to Malaguti's *chloroxethose* C_4H_6O, which he obtained by abstracting four atoms of chlorine from perchlorinated ethylic oxide $C_4Cl_{10}O$. According to this analogy, the compound $C_4H_4Cl_6O$ may be designated as *hexchlorinated ethylic oxide*, and $C_4H_2Cl_4Br_4O$ as *tetrachloro-tetrabrominated ethylic oxide*. The two compounds C_4Cl_6O and $C_4H_2Cl_4O$ may also be regarded, respectively, as *perchlorinated vinyl oxide* and *tetrachlorinated vinyl oxide*.—[Giornale di Scienze di Palermo, v. 123, 127.]

Colouring Matter of Wine

FR. PONCHIN proposes the use of a solution of potassium permanganate acidulated with sulphuric acid to distinguish between the natural colouring matter of wine and the various substances added to imitate that colour. For this purpose a normal solution of 2 grammes of the permanganate in 100 grammes of distilled water is prepared when wanted for use; 15 grammes of this solution acidulated, and 3 drops of pure sulphuric acid, are added to 15 grammes of normal red wine contained in a test-tube, and the liquid after being shaken is left at rest. The greater part of the colouring matter is then slowly precipitated in red flocks, while the supernatant liquid retains the same colour, without weakening, for 24 hours afterwards. After a few days, however, the precipitate acquires a deeper red colour and the liquid becomes nearly colourless. For very deeply coloured wines a larger proportion of the normal solution must be used, care being, however, taken not to add it in excess, as that would produce complete decolorisation. If, on the other hand, the same solution be added in the same quantities to wine which has been artificially coloured red, the deception will soon become apparent by the speedy decolorisation of the liquid, or by the communication of some different colour to the liquid and to the precipitate. The following table exhibits the various colours assumed by the liquid and precipitate produced under these circumstances in wine coloured by different substances—

Substances added.	*Colour of Liquid.*	*Colour of Precipitate.*
Pernambuco wood	Light orange red	Reddish yellow
Campeachy wood	Golden yellow	Orange yellow
Archil	Very light red	Reddish yellow
Laccamuffa	Very light green	Greenish-grey
Prepared Cochineal	Nearly colourless	Grey
Fitolacca	Nearly colourless	Yellowish
Myrtle	Nearly colourless	Dingy-greenish
Violets	Very light rose	Yellowish
Colouring matter of normal wine	Persistent wine-red.	Blood-red

Dye-woods resist decolorisation more strongly than vegetable juices; and Brazil wood, when treated with the above-mentioned reagent, aided by heat, acquires a crimson-red colour, due to the formation of brazilin.—[Ann. di Chim. app. alla Med., September, 1869, p. 142.]

PHYSICS

Professor Magnus on Heat Spectra.

Professor Magnus has recently contributed to the Berlin Academy a memoir on the radiation and absorption of heat at low temperatures. The results, which are of the highest importance, are essentially as follows:—

1. Different bodies, heated to 150° C., radiate different kinds of heat.

2. Some substances emit only one kind, some many kinds, of heat.

3. Of the first class, perfectly pure rock-salt is an instance. Just as its incandescent vapour, or that of one of its constituents (sodium), is solitary in tint, so the substance itself, even at 150°, emits heat of but a single ray. It is monothermic, just as its vapour is monochromatic.

4. Rock-salt absorbs heat radiated from rock-salt in larger quantity, and more powerfully, than that derived from sylvine and other kinds. It does not, therefore, as maintained by Melloni and Knoblauch, transmit heat from all sources with uniform facility.

5. The amount of absorption effected by rock-salt increases with the thickness of the absorbing plate.

6. The high diathermancy of rock-salt, does not depend on its small absorptive power for the different kinds of heat, but on the fact that it only radiates (and, consequently, only absorbs) heat of one kind; while almost all other bodies at the temperature of 150° emit heat which contains only a small fraction or none of those rays which are given out by rock-salt.

7. Sylvine (potassium chloride) behaves like rock-salt, but is not monothermic to an equal extent. This circumstance is also obviously in analogy with the incandescent vapour of the salt, or of potassium, which is known to furnish an almost continuous spectrum.

8. Heat purely derived from rock-salt is almost completely absorbed by fluor-spar. It might thence have been expected that heat radiated from fluor-spar would also be energetically absorbed by rock-salt; yet 70 per cent. of it traverse a plate of rock-salt 20 mm. in thickness. If we remember that the total heat emitted by fluor-spar is more than thrice as large as that of rock-salt, this phenomenon is readily explicable; nevertheless, it is probably dependent upon some other property of fluor-spar.

9. If a spectrum could be projected of the heat radiated at 150°, and rock-salt were the radiating substance, such a spectrum would contain only *one* band. If sylvine were employed, the spectrum would be more expanded, but still would only include a small portion of the spectrum which would be given by the heat radiated from lamp-black.

In a subsequent communication, Herr Magnus treats of the reflection of heat radiated at the surfaces of fluor-spar and other bodies.

Having succeeded in obtaining the heat from different substances at 150° free from the rays of flames and other thermogenic bodies, and afforded proof that there are some substances which emit waves of one or but few lengths, while others present them in more frequent variety, it next appeared interesting to solve the problem how bodies behave with reference to reflective power; whether, in bodies which act similarly upon light, differences parallel to those which are observed in respect of the absorption and transmission of heat do not also occur in its reflection.

Differences in reflective power are unmistakably apparent only when rays are reflected which have a uniform, or but slightly varying, length. Such rays have already been derived either from a section of the spectrum furnished by a rock-salt prism, or by transmitting the rays from a source of heat of many wave-lengths through substances which absorb a number of them. There are, however, but very few bodies that transmit rays of only one or a few wave-lengths; moreover, such rays, obtained by either method, have a very low intensity.

In spite of this difficulty, MM. de la Provostaye and Desains showed, as early as 1849, that different quantities of the heat from a Locatelli's lamp were reflected from speculum metal, silver and platinum, according as it had been conducted through glass or rock-salt; and, for reflecting surfaces of all kinds, less in the case of glass than in that of rock-salt.

Soon afterwards, by an extended series of experiments, and employing the prismatically dispersed heat of a lamp, it was proved by the same physicists that heat from the different portions of the spectrum is differently reflected. But, doubtless in consequence of the low intensity of the incident heat, their researches had reference solely to reflection by means of metallic surfaces. Now, if in rock-salt we possess a substance that emits waves of only one or but few lengths, and are acquainted with other bodies which, at 150°, also radiate but a few kinds, researches can be instituted on reflection at non-metallic surfaces. It has thus appeared that the different kinds of heat or wave-lengths are reflected from such surfaces in very different proportions. One of the most striking examples may here be adduced: it refers to the reflective power of fluor-spar.

Of the heat radiated by a great variety of substances, unequal (though but slightly differing) amounts were reflected at an angle of 45°; being in the case of—

Silver	between	83	and	90	per cent.
Glass	,,	6	,,	14	,,
Rock-salt	,,	5	,,	12	,,
Fluor-spar	,,	6	,,	10	,,

But of the heat from rock-salt, fluor-spar reflected 28 to 30 per cent., whereas silver, glass, and rock-salt returned no more of this heat than in the preceding cases.

Here, too, it was evident, as in the experiments on thermic transmission, that sylvine emits, besides a large quantity of the rock-salt kind, species of heat of another nature. Fluor-spar reflects 15 to 17 per cent. of the heat from sylvine; less, consequently, than that from rock-salt, and more than that from the other radiating bodies.

Granted an eye that could distinguish different wave-lengths of heat in the same manner as wave-lengths of light, and when the waves from rock-salt are incident upon different bodies, fluor-spar will appear to it brighter than any. If the rays are derived from sylvine, fluor-spar would seem still brighter than all the above bodies, but not so bright as when submitted to the rock-salt rays.

Melloni has shown that different substances transmit heat in very unequal proportions, and that the source of heat has a marked influence on the facility of transmission. Still, the sources of heat were only distinguished by degree; it was merely recognised that an increased temperature corresponds to increased variability of wave length. It now appears that at one and the same temperature, and *that*—viz., 150°—far below incandescence, different substances emit very different kinds of heat, and that, within such a range, an extraordinarily large number of different heat-rays or wave-lengths continually intermingle. This manifold intermixture is particularly furthered by the selective reflection taking place at the different surfaces.

It follows from what has been said that an eye capable of discerning the different wave-lengths of heat, as it can now discriminate the colours of light, would perceive, with very little warmth to itself, every possible variety of tint in surrounding objects.

PHYSIOLOGY

Pettenkofer on Cholera

Nearly the whole of the second part of the Zeitschrift für Biologie, bd. v. (300 pages), is taken up by a long memoir by Prof. Von Pettenkofer on "Soil and Sock-water in their

Relations to Cholera and Typhus" (Boden und Grundwasser in ihren Beziehungen zu Cholera und Typhus) in which he developes at length his views. To many these are probably now well known, but still, it may be perhaps as well to state that they are somewhat as follows.

The phenomena of Cholera result from the introduction into the animal system of a cholera poison, which is possibly an organic being, and which we may call *z*. Now, *z* is non-reproductive; does not of itself multiply or spread. But there is another distinct thing, the cholera germ (originating in India), which we may call *x*. *x* of itself will not produce cholera symptoms. It may remain, and probably may multiply in the human body, and be carried in or on the body from place to place without *of itself* producing cholera. Cholera symptoms can only be brought about by *z*, and *x* can only give rise to cholera, indirectly, by generating *z*. But *x*, in order that it may generate *z*, must come in contact with and act upon another substance, which we may call *y*. That is, *x* cannot germinate into *z* unless it meets with the substratum *y*; or we may use the idea, thrown out we believe by Dr. Farr, and imagine *x* and *y* to be the male and female parents of the offspring *z*, which is either sterile, or can only reproduce *x*.

Thus, then, *x* originating at certain times in India, and meeting with *y* at once gives rise to *z*, and an outbreak of cholera is the result. The quantity of *z* is probably more than sufficient to account for all the cases that occur; the surplus may even perhaps be carried about, and so spread the epidemic; but there being no reproduction of *z*, the stock would soon be exhausted. With *z*, however, a quantity of *x* is also carried about, more particularly by the excrement; *x*, in fact, clings to its products just as yeast cells cling to a fermented liquid. And whenever *x* meets with fresh *y*, it generates fresh *z*; and so the epidemic travels on, *x* making itself felt by *z* whenever it falls upon a store of *y*. For the existence of *y*, certain things are necessary, to wit:—

1. A soil which, like alluvium, is permeable to air and water for several feet deep.
2. A rise and fall of sock-water. A soil which is permanently dry, or one which is always filled with sock-water, are equally unfavourable for the development of *v*. The change of level of water is absolutely necessary.
3. The presence of organic and mineral matters on which the variations in the amount of sock-water may act, and out of them produce *y*.
4. A temperature suitable for such processes of organic evolution.

All these points and many others are fully discussed in a series of chapters with such headings as "Porous and Compact Soils"; "The Soil and the Immunity of Wirzburg"; "Influence of drinking Water on Cholera epidemics"; "Considerations on the Cholera epidemic of 1866 in East London, in reference to Soil and Sock-water conditions"; "Apparent evidences against the 'Soil and Water theory' and for the theory of 'Contact and Idiosyncrasy,'" &c. &c. It concludes with a series of aphorisms, "On the Origin and Spread of Cholera"; "On the Influence of Variations in Sock-level on the Enteric Fever of Munich"; and, "On the Causes of the Immunity of Lyons."

SOCIETIES AND ACADEMIES.

Zoological Society.—The first scientific meeting for the session will be held on Thursday the 11th inst., when Prof. Flower, F.R.S., will read a paper on the Anatomy of the Aard-Wolf (*Proteles cristatus*). The following communications have been received since the last meeting:—Dr. J. Anderson: Letter received from, describing a living specimen of the Pigmy hog of Terai (*Porcula salvania*).—Mr. P. L. Sclater: Remarks on the condition of various Zoological Gardens on the Continent recently visited by him, and on new and rare animals observed in those establishments.—Dr. B. Simpson. Notes on *Ailurus fulgens*.—Mr. John Brazier: Note on the Egg of a species of *Megapodius* from Bank's Islands.—Surgeon Francis Day: Remarks on fishes in Calcutta Museum.—Mr. John Brazier: Notes on the Localities of two Species of Land-Shells.—Mr. R. B. Sharpe: Additional Notes on the genus *Ceyx*.—Dr. George Bennett: Letter received from, on the habits of the Wood Hen of Lord Howe's Island.—Dr. J. E. Gray: On the Guemul or Roe Buck from Tinta, South Peru.—Dr. A. Günther: Report on two collections of Indian Reptiles.—Mr. Morton Allport: Letter received from, on the introduction of Salmon into the Australian Colonies.—Rev. O. P. Cambridge: Notes on some Spiders and Scorpions from St. Helena, with descriptions of new species.—The Secretary: On additions to the Menagerie during June, July, August, and September.—Mr. W. T. Fraser: Letter received from, respecting the Existence of the Rhinoceros in Borneo.

MANCHESTER.

Literary and Philosophical Society, October.—Mr. E. W. Binney, F.R.S. in the Chair. The following extract of a letter from Dr. Joule, F.R.S., dated Southport, October 5th, 1869, and addressed to the Chairman, was read:—"I enclose a rough drawing of the appearance of the setting sun. Mr. Baxendell noticed the fact that at the moment of the departure of the sun below the horizon, the last glimpse is coloured bluish green. On two or three occasions I have noticed this, and also near sunset that just at the upper edge, where bands of the sun's disk are separated one after the other by refraction, each band becomes coloured blue just before it vanishes."

PARIS.

Academy of Sciences, October 25.—M. L. Pasteur communicated a note relative to the dispute which has arisen between him and M. Thenard on the subject of his patented process for preserving wines by the application of heat. A paper was read by M. Phillips on the Movement of similar solid Elastic Bodies, supplementary to a memoir on the equilibrium of such bodies, read in January last.

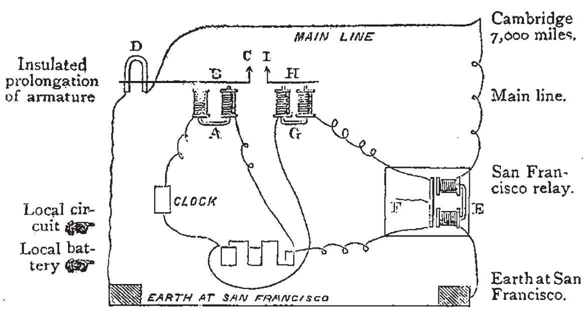
A memoir on the fundamental Equations of the mechanical theory of Heat, by M. F. Reech, was presented by M. Regnault. In a note on the illumination of transparent bodies by polarised Light, M. A. Lallemand described some new experiments with transparent solids. On passing a ray of polarised light horizontally through a polished cube of glass in a direction perpendicular to two of its faces, the maximum of illumination is horizontal, the light emitted is white, is entirely polarised in a horizontal plane, and gives the principal lines of the solar spectrum. When viewed vertically, the illumination is nil, unless the glass be fluorescent. The light observed in a vertical direction in the latter case is more or less coloured, is neutral to the polariscope, and gives none of the lines of the solar spectrum. The author noticed the behaviour of various other substances, such as crystal, fluor spar, Iceland spar, &c., M. Dumas communicated a letter from M. P. Volpicelli on the Heat of the Lunar Radiation containing an historical sketch of the researches upon this subject, and showing that both Melloni and Herschel have demonstrated the calorific action of the Moon. M. H. Marie Davy, whose previous statement (September 20, 1869) that the calorific effects of the Moon's rays were inappreciable called forth M. Volpicelli's remarks, now communicated a note on the Calorific Power of the Lunar Rays, in which, after noticing that Melloni was the first to demonstrate the existence of such a power, and that his results had been confirmed by Prof. Piazzi Smyth; he goes on to describe his own recent experiments, in which, by the employment of the thermo-electric pile, he has been able to obtain a series of results perfectly confirmatory of those of his predecessors. He found that the heat furnished by the moon is quite appreciable, and that its amount increases rapidly as it advances towards the full. M. C. Dareste communicated a memoir on the notion of Type in Teratology, and on the distribution of monstrous type in the division of vertebrate animals; the argument of which is, that the type of monstrosities is correlated with the type of organisation, so that if uniformity of type occurs in monstrosities throughout any wide range in all classes of the vertebrata, for example, the origin of such monstrosities dates from a very early period of embryonic development, and the more limited the range of a monstrosity, the later in the life of the embryo will be its origin. A paper was read by M. P. P. Dehérain on the influence exerted by different luminous rays upon the decomposition of carbonic acid and the evaporation of water by leaves. The author states that, with equal intensity, the yellow and red rays act more energetically than the blue and violet rays, both in producing evaporation, and in causing the decomposition of carbonic acid; in the latter respect he found that the leaves of *Potamogeton crispus* emitted 26·2 cub. cent. of gas under yellow light; they gave off only 5·8 cub. cent. in the same time under blue rays of equal intensity. M. E. Decaisne communicated some remarks on the various conditions of the production of goître; M. Landrin, a note on the physiological action of Chloral; M. Jaliwski, an account of a process for bronzing iron; M. Delaurier, a note on the manufacture of manganate of calcium, and M. Mehay, a note on the Infinitesimal Calculus.

PHILADELPHIA.

American Philosophical Society.—We select the following extracts from the reports of the recent meetings of this Society:—

Prof. Trego has communicated an extract from a letter from Mr. Davidson of the Coast Survey, to Mr. D. B. Smith of Germantown, detailing the method employed to obtain the recent determination of longitude and the velocity of the electric current between Cambridge and San Francisco.

"I give you the first written news not only of our telegraph longitude success, but of the success of my plan for determining the *time of transmission of clock signals from my clock to Cambridge and back*, over 7,000 miles of wire, through 13 repeaters and a multitude of relays. Through the liberality of the Western Union Telegraph Company, I had two trans-continental lines placed at my use, and last night I succeeded beautifully. My circuit was as follows. My clock breaks the local circuit every second, depriving the helix A of its electricity, and the magnet of its magnetism. This relieves the armature B, which is drawn away by a spring, and the pen C makes its record on the revolving cylinders of the chronograph. At the same instant the main current to Cambridge and back is broken by the insulated prolongation of the armature at D, and the break transmitted to Cambridge and back, through 7,000 miles of



C. Sending pen. I. Receiving pen.

SAN FRANCISCO CHRONOGRAPH.

wire, to my relay E, which relieves the armature F, and the local circuit is broken; the helix G deprived of its electricity and the magnet of its magnetism, relieving the armature H, which is drawn away by a spring, and the pen I makes the record on the revolving cylinders of the chronograph. These two pens are on the same horizontal line. Our experiments show that it took 0·87 of a second to traverse the above circuit. I also made experiments through to Buffalo, Chicago, Omaha, Cheyenne, Salt Lake, and Virginia, and back. All successful. As this experiment was not contemplated by the programme of the longitude experiments, I have the satisfaction of seeing my ingenuity successfully proved."

Prof. Kirkwood has communicated through Mr. Chase a discussion of the periodicity of the Sun's spots. We shall return to this communication.

Mr. Dubois presented a specimen and analysis of silver ore, accompanied with the following note from the Assay Office, United States Mint:—

"In the Report of the British Commission on International Coinage, lately published, we find an extract from the *Journal des Debats*, of November 13, 1866, stating that the German assayers had found the average fineness of French gold coins of that year to be 898 thousandths, and a fraction. It adds that this is an unworthy source of gain to Government, whose ambition it should be to have the coins *correct*. The *Moniteur* of November 20 (official organ) replies, that this is as near to standard as can be expected from the defects of practical operation; and that it is the duty of Government to prevent these 'ill-founded criticisms.' Our own assays, for many years, have proved a deficiency in the French coins, averaging about one-thousandth. The apology of the *Moniteur* has no just foundation. Both at this Mint, and at San Francisco, the gold coins are kept close to the mark, scarcely varying the tenth of a thousandth; as is proved by annual assays, and by foreign reports. British coinage is equally exact.

"This fact affords an argument against the project of International Coinage. If we work to 900, and France to 899 or less, and both pass alike, the difference is against us."

DIARY.

THURSDAY, NOVEMBER 4.

LINNEAN SOCIETY, at 8.—On some Brazilian Plants from the neighbourhood of the Campinas: J. Correa de Mello. On two Indian Plants: N. Dalzell. On the Occurrence of a Luminous Insect near Buenos Ayres: R. Trimen.

CHEMICAL SOCIETY, at 8.—Discussion on Dr. Williamson's Discourse on the Atomic Theory.

FRIDAY, NOVEMBER 5.

GEOLOGISTS' ASSOCIATION, at 8.—Comparative Anatomy as applied to Geology: Dr. C. Carter Blake, F.G.S.

MONDAY, NOVEMBER 8.

LONDON INSTITUTION, at 4.—Elementary Physics: Prof. Guthrie.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—President's Address. Journey to the Yellow River: Mr. Elias.

TUESDAY, NOVEMBER 9.

ETHNOLOGICAL SOCIETY, at 8.—On the Chinese Race; their Language, Government, Social Institutions, and Religion: Mr. Gardner.

WEDNESDAY, NOVEMBER 10.

GEOLOGICAL SOCIETY, at 8.—Australian Mesozoic Geology and Palæontology: C. Moore, F.G.S. On some Plant and Insect-beds in New South Wales: C. Moore, F.G.S. Further Evidence of the Affinity between Dinosauria and Birds: Prof. Huxley, F.R.S. On the Dinosauria of the Trias, with observations on the Classification of the Dinosauria: Prof. Huxley, F.R.S.

ROYAL MICROSCOPIC SOCIETY, at 8.—On High Power Definition, with Illustrative Examples: Dr. G. W. Royston Pigott, F.R.A.S. On the Structure of the Scales of certain Insects of the Order *Thysanura*: S. J. McIntire.

THURSDAY, NOVEMBER 11.

LONDON INSTITUTION, at 7.30.—On Architecture, or the Fine Art of Building: Prof. Robert Kerr.

ZOOLOGICAL SOCIETY, at 8.—On the Anatomy of the Aard-Wolf (*Proteles cristatus*: Prof. Flower, F.R.S.

LONDON MATHEMATICAL SOCIETY, at 8.—General Meeting at Burlington House.

BOOKS RECEIVED.

ENGLISH.—Chemistry: Prof. Attfield (Van Voorst).—Scenery of England and Wales: D. Mackintosh, F.G.S. (Longmans).—Practical Chemistry: Harcourt and Madan (Clarendon Press).—The Three Kingdoms of Nature: R. S. Haughton (Cassell).—Flora of Middlesex: Trimen and Dyer (Hardwicke).—Natural Philosophy in Easy Lessons: John Tyndall (Cassell).—Vegetable Physiology: Dr. Lankester (Cassell).—Our Bodies: E. A. Davidson (Cassell).—Scientific Chemistry: F. S. Barff (Groombridge).—Science of Heat: T. A. Orme (Groombridge).—Mechanical Philosophy: R. Wormell (Groombridge).—How Crops Grow (Macmillan).—Travels in Central Africa: Mr. and Mrs. Petherick (Tinsley).—New Tracks in North America: W. A. Bell (Chapman and Hall).—Intelligence of Animals: E. Menault (Cassell).—Picture Natural History (Cassell).—Gold Fields and Mineral Districts of Victoria: R. Brough Smyth (Trübner and Co.).—The World of the Sea: A. Frédol (Cassell).—Prehistoric Times: Sir John Lubbock, Bart. (Williams and Norgate).—De la Rue and Co.'s Red Letter Diaries for 1870.—Natural History of British Moths: E. Newman (Tweedie).

AMERICAN.—The Mississippi Valley: J. W. Foster.—Production of Precious Metals: W. P. Blake.—Parsons on the Rose.—System of Mineralogy: Dana and Brush.—Guide to the Study of Insects: A. S. Packard. (Through Trübner and Co.)

FOREIGN.—Echinides: Cotteau et Triger (with atlas).—Ueber Batrachier: Keferstein.—Protozoe Helvetica: W. A. and C. von F. Ooster.—Die Elliptischen Functionen: Hattendorff.—Lecons de Chimie: Alfred Riche.—Der Cultur-Ingenieur: vol. ii. part 2.—Die Chinacultur auf Java: van Gorkom.—Handbuch der Edelsteinkunde: Schrauf.—Die internationale Einigung durch das metrische System: C. Bopp.—Landwirthschaftliche Zoologie: Giebel.—Bibliothèque des Sciences naturelles (Zoologie): Gervais et Sauvage.—Erratische Bildungen im Aargau: Mühlberg.—Bergbaukunde (2 vols.): Lottner (posthumous).—Zur Kenntniss der Bryozoen: Nitsche.—Vierteljahrsschrift für öffentliche Gesundheitopflege: vol. i. part 3.—Dictionnaire technologique: Kumpf et Mothes (vols. i. iii). (Through Williams and Norgate: Asher and Co.).

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