THURSDAY, FEBRUARY 23, 1882

VIGNETTES FROM NATURE

Vignettes from Nature. By Grant Allen. (London: Chatto and Windus, 1881.)

CERTAINLY Mr. Grant Allen stands at the head of living writers as a popular exponent of the evolution theory. Although the subject is one which he has taken up a comparatively short time ago, he appears to have thoroughly mastered its principles, to have read and assimilated all the best works on the subject, and to have so imbued himself with its leading ideas that he is able to apply it in an intelligent and often original manner to every natural object he meets with in his daily walks or holiday rambles. To these primary qualifications he adds a great power of description, a vivid imagination, and a charming style of writing, all of which are displayed in every page of his last work. This consists of a series of short essays, which originally appeared in the *Pall Mall Gazette*, each giving a sketch of some single scene or natural object, and showing how much interest can be given to the most common things by considering them from the point of view of evolution. "Sedge and Wood-rush" furnish an opportunity for the explanation of degraded types and the large part played by "degeneration" in the origin of existing animals and plants. By the common "Red Campion and White" we are shown how, and by what means, species become differentiated; and the subject is further discussed and elucidated in the chapter on a "Bed of Nettles." After showing how the sting of the nettle has originated, and how it protects the plant by stinging the noses of herbivorous quadrupeds, he goes on to discuss the general form of the nettle in a way that is both suggestive and (I think) original.

"But the sting certainly does not exhaust the whole philosophy of the nettle. Look, for example, at the stem and leaves. The nettle has found its chance in life, its one fitting vacancy, among the ditches and waste places by roadsides or near cottages; and it has laid itself out for the circumstances in which it lives. Its near relative, the hop, is a twisting climber; its southern cousins, the fig and mulberry, are tall and spreading trees. But the nettle has made itself a niche in nature along the bare patches which diversify human cultivation; and it has adapted its stem and leaves to the station in life where it has pleased Providence to place it. Plants like the dock, the burdock, and the rhubarb, which lift their leaves straight above the ground, from large subterranean reservoirs of material, have usually big, broad, undivided leaves, that overshadow all beneath them, and push boldly out on every side to drink in the air and sunlight. On the other hand, regular hedgerow plants, like cleavers, chervil, herb-Robert, milfoil, and most ferns, which grow in the tangled shady undermath of the banks and thickets, have usually slender, blade-like, much divided leaves, all split up into long narrow pushing segments, because they cannot get sunlight and air enough to build up a single large, respectable, rounded leaf.

"The nettle is just half way between these two extremes. It does not grow out broad and solitary, like the burdock, nor does it creep under the hedges like the little much-divided wayside weeds; but it springs up erect in tall, thick, luxuriant clumps, growing close together, each stem fringed with a considerable number of moderate-sized, heart-shaped, toothed-and-pointed leaves. Such leaves have just room enough to expand, and to extract from the air all the carbon they need for their growth, without encroaching on one another's food supply (for it must always be remembered that leaves grow out of the air, not, as most people fancy, out of the ground), and so without the consequent necessity for dividing up into little separate narrow segments. Accordingly, this type of leaf is very common among all those plants which spring up beside the hedgerows in the same erect shrubby manner as the nettles. It is almost exactly imitated in the dead-nettle and the hemp-nettle, which are plants of a totally distinct family, with flowers of the sage and rosemary type; and it is more or less simulated by ten or twenty other species of like habit. This peculiarity of external resemblance, under identical circumstances, is a common and a natural one. . . . Whatever the original stock, natural selection tends always under like circumstances to produce like results."

Then we have the diœcious green flowers described, with the curious elasticity and irritability of the stamens, which throw out the pollen dust when the wind blows the plants about, and thus ensures abundant cross-fertilisation.

In the next chapter, "Loosestrife and Pimpernel," we have an excellent discussion on the close relationship of the wood-loosestrife or yellow-pimpernel (*Lysimachia nemorum*) to the true pimpernel (*Anagallis vulgaris*), although placed by botanists in distinct genera. Such remarks as these are very important, calling attention to the fact that the technical characters of botanists, even when drawn from the structure of the fruit, may be really of recent origin, and may not be so important as more superficial resemblances usually treated as of less systematic value. In another article on "A Big Fossil Bone" a popular misconception as to the generally large size of extinct animals is very well corrected. Everywhere we seem to find in fossil forms, a bigger animal of each kind than any now existing. Here we have an enormous Irish elk, there an immense extinct sloth, a gigantic armadillo, or a turtle ten times as big as the greatest living member of the tortoise group. But it is apt to be forgotten that the huge Saurians were secondary animals, while the dinotherium was tertiary, the mammoth quaternary, and the moa as well as the epyornis almost modern. It is forgotten that the age of the great reptiles was nearly over before that of the great mammals set in. It is forgotten that the glyptodon lived in South America, while the big elk lived in Ireland; and by picturing a world in which all the great extinct animals were grouped together as they see them in a geological museum, people get a distorted picture which really reverses the actual facts as to the relative size of the animals in the past and the present. For (Mr. Allen remarks)—

"As a matter of fact it seems probable that our actual fauna and flora are on the whole not only quite as big as any previous ones, but even a great deal bigger. If we take single instances, no known extinct animal was as large as some of our modern whales; if we look at the *ensemble* of our existing species, no known period comprised so many large forms as we can show at the present day in our three or four great cetaceans, our two elephants, our rhinoceroses, our bisons, our giraffe, our walrus, and our horses. These would probably form a total assemblage of larger average size than any previous epoch could produce. Similarly in almost every special class, we could apparently show larger species at the present day than any which we know to have existed in fossil forms. Our whale is the biggest known mammal; our gigantic salamander is the biggest known amphibian; probably our sun-fish, our tunnies, our sharks, and our devil-fish, are each in their way larger than any previous fishes—one living shark actually attaining a length of forty feet. No fossil bivalve molluscs are, to my knowledge, as big as the common Mediterranean pinna, or as that giant clam, the tridacna, whose shell is so commonly used as a basin for fountains. In fact there are only two important groups, the birds and the reptiles, in which extinct species were much larger than existing ones; and in these two groups the decrease is evidently due to the later supremacy of the mammalian type."

He then goes on to show that in many lines of descent we find groups of animals which have steadily been increasing in size from the earliest epoch of their appearance to the present day, as, for example, the horses, the deer, and the elephants. Evolution generally tends towards increase of size in dominant groups; but when a group ceases to be dominant and begins to decay its bigger members die out.

Equally interesting and suggestive are the discussions on colour and the colour-sense, *à propos* of the "Veronica" and the distribution of fishes, in "The carp pond" and "The mountain tarn"; but we pass on to the chapter devoted to "The donkey's ancestors"—a charming sketch suggested by "a dear shaggy old donkey making himself perfectly happy upon a bare rocky hillside, upon four sprouting thistles, a bit of prickly carline, and three square yards of wet turf at the outcrop of a little spring." Let us, however, pass by his pedigree (the same as that of his cousin, the horse), and see what Mr. Allen has to say about his intelligence, and the reason of it.

"Donkeys are the final flower of long ages of native evolution, the natural head and crown of one great line of mammalian development. To doubt their intelligence is to impugn the whole conduct of nature, to upset the entire system of evolutionary psychology off-hand. Donkeys cannot help being clever, because they are the final survivors in the struggle for existence in one of the most specialised, most highly developed, and most dominant mammalian stocks. They do not represent mere stranded and struggling relics of older types, like the very silly kangaroos, and ant-eaters, and hedgehogs, which drag on a miserable existence behind the times in out-of-the-way holes and corners of the earth; they are one of the finest developments of one of the most successful branches of the great ungulate tribe. I feel a genuine respect for every donkey I meet, when I remember that it was the mere accidental possession of an opposable thumb that gave my ancestors a start over his in the race for the inheritance of the earth towards the very close of the tertiary period."

In reading this most entertaining and instructive volume almost every page offers some suggestive remark or apposite illustration of the principle of evolution; and it is very rarely that we meet with anything to which exception can be taken on the score of accuracy. It is perhaps doubtful whether monkeys are "intellectually in the very front rank of the animal world," notwithstanding "the opposable thumb and the highly mobile trunk, with its tactile appendage, give these creatures an exceptional chance of grasping an object all round, and so of learning its physical properties." I am myself inclined to think they are decidedly inferior to dogs, horses, and elephants. So the tracing of man's sense of colour to the fact of our pre-human ancestors having been attracted by the bright colours of the orange, blue, and crimson fruits of tropical forests appears doubtful, if not erroneous; because the colours of such fruits are no indication of their edibility for either man or monkeys, and there is no reason they should be so, since mammalia in eating the fruits would be likely to crush and destroy the vitality of the seeds. At all events many bright coloured tropical fruits are poisonous, while many that are eatable are green and unattractive. Even among our native berries children who trust to enticing colour are apt to be poisoned by bitter-sweet or deadly nightshade. Neither is there any evidence that—

"Up to the beginning of the tertiary period, large evergreens of what is now the tropical type covered the whole world as far as the very poles themselves. Greenland and Spitzbergen then supported huge forests of the same general character as those which now spread over Brazil and the Malay Archipelago."

Nor is Buffon's idea—that organic life must have begun at the Poles, because on the surface of an incandescent planet the poles would be the first part to cool down sufficiently to allow of the conditions under which alone life becomes possible—at all in accordance with the teachings of modern science, as Mr. Allen maintains it to be. For the first cooling of the surface would necessarily occur at a time when the whole of the water of the globe was in a state of vapour, and this vast aqueous atmosphere would so far prevent the heat of the sun from reaching the surface, and so equalise radiation that there need have been no cooling at the poles earlier than at the equator; and when subsequently the water was condensed and oceans were formed, these would equalise temperature over the whole surface, and render it possible for life to originate at one part as well as at another. But these are very slight blemishes in so excellent a book, which is calculated to bring home to every reader how much of interest and novelty, of intricacy, of beauty, and of wonder, is to be found in the structure or history of the humblest plants or the most familiar animals; and also, how greatly the once-decried doctrine of evolution has added to the ideal and poetic aspects of the study of nature.

ALFRED R. WALLACE

THE COMPASS

Traité Théorique et Pratique de la Régulation et de la Compensation des Compas. Par A. Collet, Lieutenant de Vaisseau, Répétiteur à l'École Polytechnique. Ouvrage publié avec l'Autorisation de M. le Ministre de la Marine. (Paris: Challamel Ainé, 1882.)

THIS new treatise on the compass contains an admirable account of the most recent work done on the subject, and a very full and practical explanation of the objects of compass compensation and the methods adopted to secure it. It is founded on the author's translation, now twelve years old, of Smith and Evans' Admiralty Manual—made for the benefit of the French marine. That epoch-making book is however still the basis or substratum of Lieut. Collet's new work.

The practical part of the English book is fully given. M. Collet has added as much elementary mathematics and physics as he thinks may be useful to such seamen who wish to understand the whole subject from his volume, without reference to auxiliary text-books. To a slight extent he has revised the demonstrations and modified the diagrams of the Admiralty Manual—abridging these demonstrations so far as he thinks it possible to do so. He preserves Smith's notation as generally familiar. The newest part of the book is that in which he gives us the full details of the recent methods by which the amount of compensation can be determined with or without altitudes. In the account of these methods his readers will find collected much that it would be impossible for them to find in any English volume, and the exposition has all the merits of the French school. Smith and Evans showed us in their Manual how to determine the five essential coefficients upon which the deviation, when it is less than 20° in absolute value, depends at any position on the earth's surface, and for any course of the ship, three of these being constant. Two observations of the variation at any place accordingly suffice to determine the values of the deviation. Collet points out the necessity of *compensation*, that is to say, of the reduction of the five constants to insignificant values which can be determined even in a fog, when no observations of altitude can be taken, a method, of course, of the highest importance to practical men in circumstances of actual difficulty, which are constantly recurring. The theoretical part of the Admiralty Manual is given as succinctly as it is perhaps possible to give it if it is to be clearly mastered; the practical part is dwelt upon in full detail, and the rules are so simple and plain that ordinary captains in the merchant service ought to be able to use them accurately, even if they are unable to master the scientific part.

There is an excellent account of Sir William Thomson's compass. The fundamental ideas on which that instrument is constructed are that the magnetised needles must be so small that we may safely neglect their length, and that the intensity of their magnetism must be so slight that there is no reciprocal action between them and the soft iron correctors. The compass card is extremely light. A card of 10 inches diameter is directed by eight small needles, four on each side, like ordinary sewing-needles, of from 2 to 3 inches in length, and weighing in all about 3½ grammes. These are hung by two parallel silk threads, and attached to the card by silk threads passing through the two eyes at the two ends of each needle. The entire weight of the card, the needles, the outer circle of aluminium, the silk threads, the cap which rests on the vertical point, &c., is only 12 grammes, which is about 1-10th of what it is in the ordinary compass. This, of course, gives much less friction than usual between the point and the cap, so that the error due to friction is reduced in practice within a range of a quarter of a degree.

The feeble magnetic moment of the system involves two important consequences—the period of oscillation round the position of equilibrium is only about 40 seconds, whereas it is three times as much in an ordinary compass card, and the suspension by silk threads makes the whole card so elastic that it is much less liable to be prejudicially affected by any sudden shock, such, for instance, as the firing of a cannon on board.

M. Collet gives an account of the compensated compasses of Peichl, a lieutenant in the Austrian naval service. Peichl aims, like Sir William Thomson, to reduce the five coefficients used in determining the deviation to insignificant values. We must refer the reader to Mr. Collet's book to show wherein Peichl differs from Sir William Thomson's system, and wherein M. Collet considers it to be markedly inferior to it in practical value.

The fifth part of the treatise discusses the methods by which it is possible, by the use of Sir William Thomson's deflector, to compensate and to obtain the necessary corrections for the compass in foggy weather, when no observations of altitude, celestial or terrestrial, are possible. These methods are admirable, and even on an iron vessel the most improved modern compass can be trusted by the mariner almost as completely as the chronometer itself. Just as in the case of the chronometer, however, it would be foolish to neglect the opportunities of verification of the instrument which are constantly recurring on shipboard. Continually tested, and its performances brought frequently under review, it serves all the purposes of the seaman, and in foggy as well as in clear weather a captain can trust his compensated compass to navigate his ship.

The brief historical exposition of the development of the compass, which occupies forty pages, is singularly interesting. Founded as it is on the Admiralty Manual, it is reasonable to expect to find, as we do, that the immense work of English men of science should be justly appreciated, but it is not perhaps so much a matter of course that that appreciation should be as generous as it is just. The French scientific man cannot always realise that science may sometimes emanate from other centres than Paris. M. Collet is not less scrupulously just to people of other nations than a German *savant* would be, he is more generous, and his book is more readable.

OUR BOOK SHELF

Stanford's London Atlas of Universal Geography. Quarto Edition. (London: Stanford, 1882.)

THIS new atlas appears to us to be superior in many respects to the ordinary run of such works. There are forty-four maps, and the selection has been made with great judiciousness, and with a special view to adapt the atlas to an English public. Britain and her dependencies occupy a prominent position; Canada has three maps; besides Australia there is a beautiful map of Tasmania, another of New Zealand, and one of the Fiji Islands, a specially original feature. Ceylon, moreover, has a map all to itself. The two maps devoted to Turkestan are of obvious utility, and have evidently been done with great care. There is a specially good separate map of Switzerland. Of Britain, besides the general maps of each of the three kingdoms, we have a fine orographical map showing by difference of tint both the varying height of the land and the varying depths of the sea around our shores; and another map showing the distribution of the rainfall. There is a separate map of Japan, a very useful one of the Indian Archipelago, and a map of Africa in which several of the hitherto vaguely indicated Central States have had an approximate definition given to their areas. These are a few of the more prominent features of the atlas. The execution is on the whole thoroughly satisfactory; several of the maps, indeed, were originally by Arrowsmith. Appended is a copious index of places, with their latitude and longitude.

Farming for Pleasure and Profit. Eighth Section—Market Garden Husbandry for Farmers and General Cultivators. By William H. Ablett. (London: Chapman and Hall, Limited, 1881.)

THAT there is a certain amount of pleasure in farming culture as there is in every other occupation in life no one will deny, but whether the pleasure goes hand in hand with profit is another question. In these days of agricultural depression anything that can conduce to either pleasure or profit in farming would, we doubt not, be hailed by thousands; for farmers, however, to take up with market gardening in all its details as laid down by Mr. Ablett, would be to revolutionise the practice of farming as generally accepted, and to constitute themselves into market gardeners pure and simple, this the author seems to have considered impracticable, except in the neighbourhood of London or large towns where in the markets the produce can be quickly disposed of. To adopt a legal phrase we may say we do not think the author has made out a case for the more general adaptation of farm lands for market garden produce, because while fully believing that many of the more important vegetables might be cultivated on a much more extended scale, we do not see that the crops would be more profitable to the grower than those with which he is more accustomed, and which, instead of requiring an immediate sale, can be stored and disposed of at any time. But while many vegetables, more particularly root crops, as potatoes, carrots, parsnips, turnips, &c., may with profit be grown by farmers, we very much doubt whether mushrooms would be generally taken up or prove advantageous, and still less so the morell and truffle, all of which are included in Chap. X., the two latter of which the author says are not objects of cultivation in this country, a remark that is quite true, and therefore it does not form the slightest excuse for admitting even a notice of them into the book. Still less can any excuse be found for the occupation of three-quarters of a page by the Fly Agaric (*Agaricus muscarius*), a well-known poisonous species.

The final chapter of the book concludes with some remarks on flower growing, a branch of cultivation that would, we should think, seldom or never be united with that of farming proper. The book is well printed, and is freer from typographical errors than is usually the case; nevertheless there are errors in spelling that ought not to have occurred, such, for instance, as *Solanum tuberosam* for *S. tuberosum*, *Lepidum* for *Lepidium*, and *Cochlearia armorica* for *Cochlearia armoracia.* Notwithstanding that many other works exist which give full cultural details for growing market garden produce, we have no doubt that this latest production will be found of use to some growers.

The Land of the Morning; an Account of Japan and its People. By William Gray Dixon, M.A. (Edinburgh: James Gemmell, 1882.)

GENERAL works in Japan have increased so rapidly in recent years that the claims of every new writer on the subject may well be examined with attention. Those of Mr. Dixon are that he resided four years in Tôkiô as Professor in the Engineering College there, that he travelled over nearly four thousand miles of the country, including many remote and mountainous districts, and that he was thrown into contact with representatives of all classes of Japanese society from Cabinet Ministers to peasants. To these may be added the further circumstance that really accurate and valuable books, such as those of Sir Edward Reed and Miss Bird, are somewhat expensive, while Mr. Dixon desired to furnish a moderate-sized volume at a moderate price. In this we think he has succeeded. "The Land of the Morning" is a handsome volume of nearly 700 pages, with numerous illustrations. When we examine the contents of the work, we find that they are in every way worthy of their handsome exterior. After a brief and apparently accurate sketch of Japanese history, and especially of the troubles which led to the revolution of 1868, Mr. Dixon describes new Japan, its institutions, and people. This he does with a sympathy which is all the more praiseworthy that it is the result of four years' close observation, and not the newly-developed ardour of a casual visitor. We turn with especial interest to Mr. Dixon's account of Japanese students. Many young men from Japan have shown themselves matches for brilliant European students, notwithstanding the initial obstacle which they have to overcome in acquiring the language; these, however, are clearly exceptions, and we therefore look to Mr. Dixon's experience for an account of the average Japanese student. He has devoted a whole chapter to the subject, and the picture is in some respects not a pleasant one.

Devotion to study, which frequently leads to overwork and permanent ill-health; attention and respect for the teacher; good-humour; an extraordinary development of memory; some originality, a high sense of honour and much gratitude, are all found in the average student; but with these we find a self-conceit which is ridiculous, a mind clear rather than deep, and a "narrow intellectualism" which blinds him to the necessity for moral as well as intellectual development. If there is a rapid development there is also a rapid decay. The picture, we believe, is a true, albeit somewhat melancholy one.

The popular idea that Japanese isolation, which was first rudely broken by the American Commodore Perry in 1853, was the result of hostility and prejudice towards foreigners, will receive a shock from Mr. Dixon's chapter on the subject. "The real cause," he says, "of Japan's exclusiveness was a fear that free intercourse with the outside world might lead her into subjection to some foreign power." Mr. Dixon is indignant that "an American gentleman of considerable fame in biology and cognate subjects"—Prof. Morse, of Salem, we believe—"instead of keeping within his own province," preached "atheistic evolution" in a temple at Asakusa in Tôkiô; in other words, lectured on evolution and the Darwinian theory, and founded among his students a biological society which is still active and vigorous. The really good work which Prof. Morse did for education and science in Japan cannot be dismissed by a few abusive epithets, and we cannot help thinking that Mr. Dixon would have acted more discreetly, and more in accordance with the general tone of the work, had he omitted references such as these. This, however, is but a minor blot in a work of such general excellence.

A Study of the History and Meaning of the Expression "Original Gravity." By J. A. Nettleton, of the Inland Revenue Laboratory, Somerset House. (London: A. Lampray, 1881).

THIS little treatise, the substance of which appeared in the *Brewers' Guardian*, has been compiled mainly for the information of brewers and distillers, and for the use of the officers in the Inland Revenue Department, in order to permit of the original gravity of a sample of wort of beer or of distillers' wash to be determined after fermentation with a view of fixing the amount of drawback, in conformity with the Act 10 Vict. cap. 5, 1847, and the Inland Revenue Act, 1880. There are four different methods in more or less common use for determining "original gravity" These are very fully described and the incidental errors carefully noted; preference is very properly given to the distillation process of Dobson and Phillips, with the modifications in the tables rendered necessary by the investigations of Graham, Hofmann, and Redwood, made at the instance of the Board of Inland Revenue. We can recommend the work as a thoroughly trustworthy guide to the brewer and distiller in a matter of great practical importance to their trades.

LETTERS TO THE EDITOR

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

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Hypothetical High Tides

WHATEVER conclusion may ultimately prevail with regard to the existence of very high tides in the earlier epochs of which geology has cognisance, I think that geologists will hardly accept the argument by Prof. Newberry, in your last issue (p. 357) as a settlement of the question. He appears to confound together three agents whose effects widely differ, viz.: (1) tidal waves of undulation, (2) tidal waves of translation, and (3) wind waves. In waves of undulation the particles of water move only in a vertical line, and can obviously neither denude nor transport. Waves of translation, acting as currents, are transporting agents, but are very subordinate to wind waves in their denuding power. In the present state of things waves of translation, *i.e.* the tides of our inland seas and estuaries, can hardly be said to denude at all; they simply shift mud and sand from place to place. Even if their speed were enormously increased, their effect as denuding agents must still be very inferior to that of wind waves.

The picture which Prof. Newberry has drawn of an enormous current rushing round and round the globe, sweeping away continents, and destroying whole faunas, is not justified by fact. In the open ocean there would be no current at all due to tidal action, but simply, a vertical rise and fall. The Trilobites and Brachiopoda which swarmed in the Silurian seas would be conscious of no change in their surroundings save an alternate deepening and shallowing of the water over their heads. Where the tidal wave became inclosed between two lands its height would increase; but it would acquire no transporting power till it was piled up in narrow estuaries. Marine denudations would be mainly effected, as at the present day, by wind waves.

I will present Prof. Newberry with a more energetic denuding agent than his tidal wave, viz. wind waves originating in the more powerful air currents of a globe rotating at (perhaps) thrice its present speed. But what could such waves do which our present waves cannot do? They would simply work more rapidly. They would produce deposits of conglomerate, sand, and mud, which would in no respect differ from modern strata. There would be nothing in the nature of the sediments from which we could either affirm or deny the existence of a more potent engine of denudation.

Prof. Newberry attempts to show that the hypothetical tidal wave of Devonian times would prevent the formation of coral-reefs. But this argument proceeds on the assumption that the habits of the Devonian corals were identical with those of recent reef-building polypes. Since, however, the Palæozoic corals belong to extinct families, any inference as to their habits must be purely conjectural. Besides, the tidal wave must have greatly diminished by the Silurian or Devonian epoch, and may not have exceeded the 150 or 200 feet which Mr. C. Darwin fixes for the limit below which the polypes cannot live.

Prof. Newberry makes a strong point of the evidences of quietude which we find in ancient littoral zones. The hypothetic tidal wave, he thinks, must have swept over the mollusks, corals, and sea-weeds which tenant the shore, so that they would be subject to the "greatest mechanical violence," and their zone would be rendered "uninhabitable." To this I reply (1) that shores bordering on the open sea would only be exposed to a wave of undulation, and (2) that even a rushing wave of translation would do less harm than our modern wind waves, which hammer against the shores where mollusks and sea-weeds manage to spend a tolerably peaceful life.

There are other details on which I should like to join issue with Prof. Newberry, but I fear to trespass upon your valuable space. C. CALLAWAY

Wellington, Salop, February 17

SURELY Mr. Newberry has too quickly come to the conclusion with which his paper of February 16 ("Hypothetical High Tides") terminates. I think if he reconsiders the matter he will still find that there is room for discussion. Has he fully taken into consideration the fact that at present, although in some places there are tides of thirty feet or more in height, notably where the waves roll in from the open ocean to some of the more or less confined bays or estuaries, on the contrary, in confined seas on the Mediterranean, Euxine, and Baltic, the tide is scarcely perceptible? This being the case, is it satisfactorily proved that the old Potsdam beach of which Mr. Newberry speaks was not deposited on the shore of such an inland sea, where, in despite of the fact that the oceanic tides might measure 200 feet or more, yet here I think the littoral zone might be comparatively quiet; at any rate sufficiently so to support both animal and plant life? I merely make this suggestion in the hope that somebody more able to deal with the subject than I am will continue the discussion. A. HALE

Filston Hall, Shoreham, Kent, February 20

Rime Cloud observed in a Balloon

UNDER this heading (NATURE, vol. xxv. p. 337) M. de Fonvielle made an interesting communication on a cloud suspended over Paris, through which he and M. Brissonet passed in a balloon on January 25 last. Its thickness did not exceed 300 metres. "The nebulous matter," he says, "appeared perfectly homogeneous, and I could see no trace of any crystalline matter, but an unexpected observation proved that it was formed of minute solidified atoms of water in a real microscopic state of division."

While the balloon was floating over the cloud the sky was clear, and the temperature of the air from -2° to -3° C., and a rope hung from the balloon, the length of which was 60 metres, its end being immersed in the cloud. "We perceived that this part was quite loaded with hoar-frost, which had precipitated regularly in a series of hairs a few millimetres long."

During the slow ascent no deposit of ice was visible; "in our descent, which was rather quicker, but not to a great degree, the sweeping may have accumulated the frost rime on the bottom of the car, which could not have been easy to observe, and consequently I cannot state what occurred, but not a single crystal was deposited on our ropes during that period."

The mean temperature of the cloud is said to have been 5° C., but at the point at which the deposition of rime took place the temperature must have been 0° or lower. The upper layer of the cloud might have been colder than the layers below.

It is improbable that the upper part of the cloud consisted of solid water, as no trace of any crystalline matter was visible. The smallest crystals of snow are visible in the air in the thin mists formed over channels of water, for the snow crystals glisten and reflect light from their exceedingly small surfaces. M. de Fonvielle must have observed this phenomenon, as "the sun was shining in its full glory." It is more probable that the cloud was formed by small drops of liquid water cooled below zero. We know from Dufour's observations that water-drops, if they are not in contact with solid matter, and floating in a mixture of rock-oil and chloroform of equal density, may be cooled down to -10° C., and even to -20° C. if they are small enough, but become crystalline in contact with a solid body, especially a fragment of ice. The hoar-frost which we have frequently noticed this winter in Heidelberg, during hazy weather, and when the temperature was below 0°, may have been due to the solidification of such drops of mist. It covered the plants first with filigree-like ice, and then with a thick crust of the same. In consequence of this, sometimes so much ice is deposited on the stems of the trees that great damage is caused by it in the forests; this was the case in the neighbouring "Rheinpfalz" in the winter 1858-59, and in other parts of Germany, especially in Bohemia.

It is, however, well known that a thick mist may consist of crystals of ice. Equally well known is Scoresby's description of the "frost-damp" or "frost-rime" of the Arctic regions, as it forms a layer in the cold air over the warmer sea-water, the masts of the ships projecting over it. Mohn describes the "Frostzög," which is formed in winter over the Norwegian fjords, which never freeze, when cold air, sometimes at a temperature of 20° C., and even lower, blows from the land over the water, which has a temperature above 0° C.

To these interesting occurrences of mist, generally termed ice-fog, one particularly singular instance has been added by Hildebrand-Hildebrandsson's meteorological observations made during the voyage of the *Vega* (*Zeitschr. der Oesterr. Gesellsch. f.*

Meteorologie, 1881, xvi. 369; *Naturforscher*, 1882, No. 5.) During Baron Nordenskjöld's wintering nerr Pitlekaj, on the Cape Serze Kamen (near Behring Strait) in 1878-79, an ice-fog was formed by the north wind predominating there during the cold season, by which the aqueous vapour from Polynjen was blown over the cold mainland. This ice-fog rendered the air opaque to such an extent that it was found necessary, in order to find the way, to span a rope from the ship to the observatory which was erected not far off on the shore.

Heidelberg, February 11 HERMANN KOPP

Earthquake in the Andaman Islands

I SEE among the Notes in your last issue (p. 325) that there has been widespread seismic disturbance in Asia, including Ceylon, but unfortunately in no instance is the date given, which would have added very greatly to the value of the record. It may be interesting to give an extract from a letter I have just received from my brother, Mr. Harold Godwin-Austen, from Port Blair, Andaman Islands, which very probably was connected with the disturbance in Ceylon, and if so, it covered a very considerable area of the earth's surface, the distance being about 750 miles between the two places:—"Port Blair, January 2.—We had a very bad earthquake here on December 31, 1881, at 7·52 a.m. I thought the place was going to pieces. There has been a good deal of damage done to work and pucca (brick) buildings, and we had five high and low tides in three hours after the shock, and the sea did not quiet down all day. Since then we have had two or three slight shocks."

Deepdale, Reigate, February 9 H. H. GODWIN-AUSTEN

The "Overflow Bugs" in California

THE following experience from one of my correspondents, Mrs. A. E. Bush, of San José, California, is, I think, well worth publishing, as showing how Ground-beetles may be so numerous as to become a nuisance to man, the Carabidæ generally being indirectly beneficial to him by devouring plant-feeding species. The insect popularly denominated "Overflow Bug" in California is the *Platynus maculicollis*, Dej.

Washington, D.C. C. V. RILEY

"We lived in Fresno Co. two years, in the north-eastern part, and in the foot-hills of the Sierra Nevada. It is hot and dry there; no trees and many rocks where we were; thermometer ranging from 96° to 108° for about three months. In June and July, when hottest and driest, the "overflow bugs" filled the air between sunset and dark. You could not with safety open your mouth. They would light all over your clothes; they filled the house; they swarmed on the table, in the milk, sugar, flour, bread, and everywhere there was a crevice to get through. Take a garment from the wall, and you could shake out a cupfull. It was a veritable plague. In a shed where the boards had shrunk and the cracks been battened, the spaces between the shrunken boards were packed full. They were flying for about two weeks, and then they disappeared mostly or they did not fly much, but were hidden under papers, clothing, and every available place. In November, before the rains, they spread around, but not to fly; make a light in the night, and you would see the floor covered; lift up a rug, and the floor under would be black, and they would go scattering away for some other hiding-place. I had occasion to take up a floor board after they had apparently disappeared, except stragglers. The house was upon underpinning two feet or more from the ground. When the board was raised, there were the 'overflow bugs' piled up against a piece of underpinning, making such a pile as a half bushel of grain would make. They were all through the foot-hills the same, and much the same in Los Angelos, about Norfolk, but they did not fly much in the latter place. In Los Angelos they seemed to be worse before the 'Santa Annas,' a hot wind from the desert filling the air with sand; and though the chickens were ever so hungry for insects, they would not eat the 'overflow bugs.' In the night you put up your hand to brush one from your face, and then you get up for soap and water to cleanse your hand. In the morning, if you put on garments without shaking, you get them quickly off and shake them."

Solar Halo

WE were favoured here on the 16th inst. with a view of a rather unusual phenomenon. Shortly after 8 a.m., the sky being for the most part clear with detached masses of fleecy clouds towards the south, two mock suns appeared, one to the west very brilliant, the other rather fainter, and of a crimson shade at times. The halo was visible for a little distance near the western one, which, with the bar of light from the sun extending along the bank of cloud beyond, formed a perfect cross. They gradually waned, the eastern one, however, becoming once or twice more brilliant, till a little after 10, when the sky grew overcast and they disappeared. W. F. EVANS

Felsted, Essex

Auroral Display

AN auroral display was observed here last evening between 7h. and 8h. The sky was partially overcast during a portion of the time, but it cleared about 7h. 10m., when the northern quarter was lighted up by a bright glow of an aqua-marine line. Only three faint streamers were remarked. They were of a creamy-white colour, and extended from the horizon in the direction of the magnetic north nearly to the zenith. Examining the auroral light with a direct-vision spectroscope by Hilger, I saw one remarkably distinct line, which was estimated to occupy the position of the characteristic line observed by Ångström and others, between D and E. No other lines were visible.

Bedford, February 21 THOS. GWYN ELGER

A Plea for Jumbo

WILL you open your columns to a short but earnest plea for poor Jumbo, of the Zoological Gardens? No one can read the description of the attempts made to remove him without feeling that it would be a disgrace to English lovers of animals to let him be transported. To outsiders it is a mystery that Mr. Barnum should have succeeded in purchasing him, and if some means are not discovered of satisfying Mr. Barnum's claims without doing violence to the public sentiment of humanity, it will be a cause of indignation to many of us. You should hear my wife talk about the matter, but of course she is only a woman, she is certainly not a "Fellow." In this case, however, it is possible that her womanly instinct is worth more respect than the motives which have led to the sale and purchase of our favourite quadrupedal fellow-citizen. A. R.

THE CHEMISTRY OF THE ATLANTIC[1]

I.

IN this work are collected and discussed the results of the chemical investigations on the nature of the water of the North Atlantic, made during the Norwegian expeditions of the summers 1876, 1877, and 1878. The contents of the volume are divided into three chapters—I. On the Air in Sea Water; II. On the Carbonic Acid in Sea Water; and III. On the Amount of Salt in the Water of the Norwegian Sea. It is therefore wholly concerned with the chemistry of the water; chemical researches in other directions are promised for a future volume. Although the subject is thus restricted, there is abundant matter of the greatest interest both from a chemical and from a geographical point of view.

Apart from isolated experiments, the first occasion on which the gaseous contents of sea-water were the object of systematic and successful study was during the German expeditions to the Baltic and the North Sea in 1871 and 1872 in the *Pomerania*. In the *Lightning* and the *Porcupine* attempts had been made to examine the water in this direction, but the results were not satisfactory. In order to determine the gaseous contents of a sample of water it is necessary first to eliminate and separate the gas from the water, and then to analyse it; and these form two distinct operations—one, the former, of which can be carried out perfectly on board ship; the other requires the steadiness of a shore laboratory. On board the *Lightning* and the *Porcupine* the mistake was made of attempting the analysis as well as the extraction of the air on board.

[1] The Norwegian North Atlantic Expedition, 1876-78. Chemistry. By Hercules Tornøe. (Christiania: Grøndal and Son, 1880.)

Dr. Jacobsen, the chemist of the *Pomerania* Expedition, has the merit of being the first to have rendered practicable the carrying out of such operations as the extraction of the gases and the determination of the carbonic acid in sea-water at sea. In subsequent expeditions his apparatus has been used with but slight modifications. His apparatus for extracting the oxygen and nitrogen was used on board the *Challenger* and by Dr. Tornoe without alteration; the method of determining the carbonic acid was modified both on board the *Challenger* and on the Norwegian expedition.

In the first chapter, "On the Air in Sea Water," Dr. Tornoe describes the apparatus used for obtaining samples of the water at different depths. In principle it resembles most other instruments devised for the same purpose, consisting of a tube which is open at both ends while descending, thus allowing the water to pass freely through it. On reversing the motion, the two ends are closed by conical valves worked by screw fans. In construction, however, it differs widely from other instruments of the same kind. Instead of being straight the tube, which forms the body of the instrument, is spiral, and holds about five litres. The diameter of the tube is 5·5 centimetres, and the external diameter of the spiral is 33·5 cm., the total length of the instrument over all being 144 cm., or nearly 5 feet. These measurements are taken from the plate accompanying the book, and it is apparent from them that the instrument is one of very considerable size; it is a pity that its weight is not given. Both ends of the spiral tube have conical valve seats, the smallest diameter of which is equal to that of the tube. The valves fitting these apertures are kept open during descent by the action of screw-fans, which turn in one direction during descent; when the direction of the motion is reversed and the ascent commenced, the first few turns of the screw-fans are used for bringing the valves close to their seats, when, being released from the screws, they are pressed home by a pair of spiral springs. In order to do the necessary work on the screws, the instrument has to travel through about seven fathoms of water. The water, therefore, which it brings up will be a fair average sample of the particular seven fathoms through which it was drawn. The instrument appears to have given great satisfaction, and it has many good points in its construction. The spiral form of the tube is an ingenious contrivance for increasing its capacity without unduly lengthening the whole apparatus, but the spiral form also produces an increased resistance to the passage of the water, so that what passes through will lag behind what passes outside the instrument. Hence the sample actually inside the tube at any moment is a sample of the water a certain number of fathoms above it, and not of the water in the centre of which it is plunged. For ocean work this is not a serious drawback, and it is in a great measure corrected by the necessity for hauling it backwards through seven fathoms of water before it is closed. The arrangement for working the valves is very ingenious, and permits the use of several instruments on one line, for the instrument requires to traverse seven fathoms of water in order to close, and this is much more than would be traversed by it with the line held fast and exposed only to the rolling motion of the ship. This advantage, however, is rendered nugatory by the great size of the instrument, as one of them would be a sufficient load for any line. It is evident that for taking samples at small intervals of depth as every five fathoms, the instrument would have to be modified, or one of the other existing forms used; but for the collection of the samples which actually were taken, the instrument was quite satisfactory. Its inventor was Capt. C. Wille of the Norwegian navy.

The apparatus used for boiling out the gases is exactly that recommended and figured by Jacobsen in Liebig's *Annalen*, vol. 167, p. 1. It consists of three parts—*a*, the flask for the reception of the sea water to be boiled, its capacity is about 900 cub. centims.; *b*, the bulb tube, fitted into the mouth of the flask by an india-rubber cork, which, with the tube, forms a most ingenious kind of slide-valve, enabling connection between the flask and the remainder of the apparatus to be made or broken at will. This bulb-tube serves a double purpose: at first it contains a supply of distilled water, which, being converted into steam, drives all the air out of the upper part of the apparatus, and so enables a vacuum to be formed; in the latter part of the operation it serves for the reception of the sea water which expands into it out of the flask during the process of boiling. The third part of the apparatus, *c*, is the gas-tube in which the sample of gas is sealed up and preserved when it has been extracted from the water. This tube, which ought to have a capacity of about 60 or 70 cub. centims., resembles a pipette whose end-tubes are reduced to a length of 5 or 6 centimetres, and are contracted to a very small diameter near the body. It is attached to the bulb-tube by a piece of good india-rubber tubing, care being taken that the ends of the two tubes abut. By the boiling of the distilled water in the bulb-tube at the commencement of the operation all the air is expelled, and the apparatus hermetically closed by sealing up the gas-tube at the contraction at its upper end. During this operation communication is interrupted, by means of the slide-valve, between the flask and the bulb-tube. After the upper end of the gas-tube has been closed, communication is re-established, and the water in the flask now finds itself exposed to the action of a tolerably good vacuum, and in consequence the air dissolved in it immediately begins to be disengaged; this is assisted by heating in a water-bath. When it is judged that the air has all been expelled from the water, the flask is again isolated by means of the slide-valve, and the gas-tube sealed up at the lower contraction and preserved for analysis. As there is always some of the gas remaining in the bulb-tube, the space so occupied is measured and noted, so as to be taken into account in determining the total volume of gas per volume of water. The beautiful part of this apparatus is the slide-valve arrangement, which was invented by Dr. Behrens of Kiel. Otherwise the apparatus does not differ from that described by Bunsen, and used by him in Iceland. Had it, however, been necessary to use Bunsen's apparatus unmodified, it may safely be assumed that we should now have very few analyses of the air dissolved in sea water. It is Dr. Behrens' invention which renders the operation sufficiently easy to enable it to be carried out successfully as a matter of routine at sea.

There is another item in the construction of the instrument which, though apparently insignificant, is really of the utmost importance in insuring a successful result—it is the way in which the contraction in the two end tubes of the gas tube is made. The tubes supplied to the Norwegian Expedition seem to have been much the same as those supplied to the *Challenger*. Both came from Thuringia in Germany, and in the *Challenger* ones the contraction was formed by thickening up the tubes before the blowpipe, so that the external diameter was not diminished, while the internal diameter was reduced often beyond what was necessary. Now in attempting to close the tube with the blowpipe at one of these thickened contractions, the thin and comparatively wide tube on either side of the thick contraction is very apt to be heated up to softening point before the much more massive contraction has got even hot. In the inside of the tube, however, there is, even after the boiling, a much lower pressure than in the outside atmosphere; consequently, immediately the tube next the contraction gets soft, it falls in, and though the tube may be drawn out, and so appear for the moment to be satisfactorily closed, the point so formed never fails to crack on cooling. This is the reason of the deplorable loss of as much as 75 per cent. of the gas samples boiled out by Dr. Tornoe on his last voyage. A similar experience was made with the first few samples boiled out on board the *Challenger*, but it was detected in time to prevent any serious loss. Indeed from dust and particles of sawdust having got into the tubes, it was necessary in every case, before using a gas tube, to remove its end tubes, clean the body thoroughly, re-attach the end tubes, and *draw out* the thickened contraction. When so drawn out, there is not the same mass of glass to be heated, and the contracted part can be heated for itself without any danger of softening the wide part. There was no instance of a tube cracking after being sealed up with these precautions. In recent practice the writer has considerably modified and improved the apparatus for extracting gases from water on shipboard, but a description of the apparatus would here be out of place.

The figures representing the results of the analyses are necessarily affected by errors incident to the collection and the transvasing of the water and to the separation and analysis of the gas. The combined effect of these errors can be appreciated by the study of the following table, in which are collected the results of analyses made in duplicate. It is not stated whether on each occasion two separate and distinct samples were collected and treated separately, or, from the same sample of water, two portions were separately boiled, and thus two portions of gas obtained for analysis. Of the nine waters so treated four came from the surface, three from the bottom, and one from an intermediate depth of 300 fathoms.

Table of Duplicate Analyses

Station No.	Depth (fathoms).	O + N cc. per litre.	Difference.	Oxygen per cent.	Difference.
125	700 (Bottom)	20·5 20·0	0·5	33·0 33·6	0·6
162	795 (Bottom)	20·6 19·4	1·2	32·6 33·7	1·1
213	1760 (Bottom)	19·6 —	—	34·0 33·8	0·2
332	1149 (Bottom)	21·9 22·0	0·1	32·2 31·8	0·4
345	300 (Intermediate)	20·9 21·5	0·6	34·4 33·9	0·5
183	Surface	20·0 —	—	36·1 36·1	0·0
283	Surface	19·8 19·5	0·3	35·4 35·3	0·1
—	Surface	20·7 —	—	35·8 35·4	0·4
323	Surface	19·3 —	—	36·5 35·8	0·7

From this table we see that the mean difference in oxygen per cent. as found in the different analyses of the gas from the same water was 0·5. The differences in the total volume of nitrogen and oxygen per litre varied from 0·1 cc. to 1·2 cc.

Dr. Tornoe has collected at pp. 15 and 16 the results of his analyses of ninety-four samples of air extracted from water of various depths. Of these thirty-three are from surface water, eighteen from intermediate, and forty-three from bottom water. The last-mentioned are from a great variety of depths, ranging from 25 to 1760 fathoms. His results give us a very complete account of the state of aëration of the water of the "Norwegian Sea," or of that part of the ocean extending from the Faröe Islands northwards to Spitzbergen, having for the greatest part of its length the shores of Norway for its eastern boundary. The investigations were carried on between the middle of June and the middle of August, or during the height of summer, consequently the temperature of the surface water was never either very high or very low. In the table of results the temperature of the water is given. Of the surface waters examined the mean temperature was 6·6° C., the highest being 11·8°, and the lowest 0·5° C. If the total volume of the oxygen and nitrogen be taken to be 100, then the oxygen was found to vary between 33·7 and 36·7, mean 35·4. The absolute amounts of the gases varied with the temperature.

The results obtained by Jacobsen in the *Pomerania* showed a very remarkable agreement in the percentages of oxygen found in the surface water. The mean results of twenty-one observations were as follows:—Temperature 16·66° C., nitrogen 11·07 cc., oxygen 5·69 cc., together 16·76 cc. per litre, and oxygen percentage 33·93. The lowest oxygen percentage was 33·64, and the highest 34·14. From this it was concluded that the percentage of oxygen in sea water is practically invariable, as it is in the atmosphere. For the limited area explored by the *Pomerania* this is undoubtedly proved, but the area was comparatively small and the variations in conditions, especially temperature, insignificant. In the *Challenger*, waters subject to the most varied conditions of climate were treated for the extraction of the gases, and before leaving the work of the expedition, now more than four years ago, the writer had analysed a considerable number of the samples of gas so procured. The results of these analyses showed at once that Jacobsen's conclusion as to the ocean as a whole was not justified, while it held good with regard to limited areas. If we confine our attention to surface water, the highest percentage was 35·01 in the Antarctic Sea, and the lowest 32·35 in the Pacific, between Fiji and Torres Straits. This was however a very remarkable water, and should be excepted. The next lowest percentage was 32·82, so that in round figures the oxygen percentage varied between 33 and 35. As the cruise of the *Challenger* was chiefly in tropical regions, the surface water had usually a high temperature; but water of all temperatures was experimented on, and if the results are arranged in ascending order of temperature, the oxygen percentage is seen to decrease very regularly.

In waters of temperatures above 20° C. the percentages ranged between 32·82 and 33·33, the mean of nine such observations being 33·09. The mean of five observations between 12° and 20° is 34·22, the extremes being 33·52 and 34·66. We gather from the results of the three expeditions that the percentage of oxygen is less in warm water than in cold.

In order to judge of the degree of saturation of the waters Dr. Tornoe reports some interesting experiments on the absorptive power of sea water for the atmospheric gases at different temperatures. He experimented on four temperatures, namely, 0° C., 5°, 10°, and 15° C., and from the results so obtained he gives the following formulæ for the solubility of nitrogen and oxygen in sea water exposed to a current of air:—

$$N = 14{\cdot}4 - 0{\cdot}23\,t$$
and
$$O = 7{\cdot}79 - 0{\cdot}2\,t + 0{\cdot}005\,t^2.$$

The formula for nitrogen agrees with the facts of his observations at the four temperatures: that for oxygen begins to fail at the highest temperature, 15° C., and is clearly inapplicable at temperatures above 15° C., for it gives a minimum of solubility at 20°, and at 40° C. this solubility is the same as at 0° C., and is increasing.

The analyses of the gas from surface water do not agree very well with the figures given by his nitrogen formula. Jacobsen's results are also higher than would be given by the formula, and the *Challenger* results considerably higher. The last are better represented by the formula—

$$N = 15{\cdot}8 - 0{\cdot}23\,t.$$

Dr. Tornoe notices that the oxygen found by him in surface water is considerably in excess of what would be given by his formula, but as the formula is clearly inaccurate for temperatures above 10° C. it is premature to conclude, as he does, that the surface water is supersaturated with oxygen. J. Y. BUCHANAN

(*To be continued.*)

THE BOSTON SOCIETY OF NATURAL HISTORY, 1830-1880

THE Boston Society of Natural History was founded in 1830 by a few earnest men, and in 1880 it resolved to commemorate its fiftieth anniversary by the publication of an historical sketch of its origin and life, and of a special series of scientific memoirs. This resolution has been carried into effect by the issue of a splendid quarto volume of over 600 pages and 40 plates, the paper and typography of which is worthy of the Boston Press.

Very interesting is the account given of the early struggles and early successes of this now so well-known institution. Preceded by the Linnean Society of Boston (founded in 1814), which at first made rapid progress and then gradually fell away, it was duly constituted in May, 1830, with Thomas Nuttall as president. At this time, Mr. S. H. Scudder states, there was not in New England an institution devoted to the study of natural history; there was not a college, except Yale, where even the modern views of geology were taught. The few labourers in the field of natural science worked alone, without aid or encouragement, and were regarded as triflers by a busy public. To go through the records of its early days, however briefly, would take up too much of the space at our disposal.

Once started into existence, the Society found itself with the responsibility of a rapidly increasing museum; and the demands upon its pecuniary resources, even though an enormous amount of gratuitous service was rendered by the members, soon began to be very troublesome. Generous and wealthy members replenished the empty treasury, and after its first ten years' existence (1830-40) it found itself, after a hard pinch, just free from debt. In 1841 the publication of the *Journal* of the proceedings commenced. Louis Agassiz joined the Society in 1847. Dr. Amos Burney, its president, died the same year at Rome. In 1848 the members assembled in a new house in Mason Street, and the close of a second decade (1840-1850) found them just holding their own.

Already in 1855 it became evident that the new abode was becoming all too small for the collections; and now it was well for the Society that they found so good a friend in John C. Warren, for he largely assisted in procuring the means for purchasing the present accommodation, though another ten years (1850-60) passed away, and it was not until 1861 that Dr. William J. Walker presented the Society with the estate in Bulfinch Street, where the Society's fine museum and library now stands. The magnificent donation of 10,000 dollars from Mr. Jonathan Philips, the products of the sale of the house in Mason Street, with many generous subscriptions, enabled the Society to think of building on the site presented to them by Dr. Walker, but on consideration they found that they had not more than half the money amount required. In this emergency Dr. Walker came again to their aid, presenting them with a gift of 20,000 dollars, on condition that a further sum of like amount were raised. The year 1864 found the Society in its present handsome edifice (the building of which had cost 80,000 dollars) and trying to solve the problem of how to keep up so spacious a mansion on its comparatively small resources. With wondrous liberality Dr. Walker once more offered a donation of 20,000 dollars, on the condition that a like amount were subscribed by others, the whole to form a working capital to be funded. This became an accomplished fact in May, 1864, but this was not all, for on Dr. Walker's death in April, 1865, it was found that he had left by will a large fortune to the Society, and following this good example ere this fourth (1860-70) decade passed away, other liberal members had subscribed some 50,000 dollars to the capital of the Society, thus establishing the Institution on such a firm foundation as to secure its perpetuity as long as wisdom shall prevail in its Councils. Its property, besides the buildings with their inestimable contents, consisted of vested funds, amounting to 186,898·20 dollars, and a fair annual income from members.

The fifth decade, the celebrating of the close of which took place in April, 1880, was chiefly noted for the progress that was made in a scientific arrangement of the collections of the Society, under the custodianship of Mr. Hyatt; by the deaths (1874) of Louis Agassiz, about whose early career some very interesting facts are given, and (1874) of Jeffries Wyman, of whom there is a short biography, of Charles Pickering 1878), of C. F. Hartt (1868), and of T. M. Brewer (1880).

There is a very valuable account of the Teachers' School of Science, which seems in Boston to have attained a great success, and a summary of the general contents of the Museum. Very excellent portraits of Benjamin D. Greene, George B. Emerson, Amos Binney, J. C. Warren, Jeffries Wyman, and Thomas T. Bouvé, being the first six presidents of the Society, accompany this part of the volume and also a history of Dr. William J. Walker, and engravings of the portraits of A. A. Gould and Dr. Humphreys Storer.

The second portion of this fine memorial volume is devoted to the publication and illustration of a series of memoirs, of which we must be content with the bare enumeration of their titles. These are thirteen in number, and are profusely illustrated: N. S. Shaler, Propositions concerning the Classification of Lavas considered with Reference to the circumstances of their Extrusion; A. Hyatt, the Genesis and Evolution of the Species of Planorbis at Steinheim (ten plates and a map); S. H. Scudder, the Devonian Insects of New Brunswick, with a Note on the Geological Relations of the Fossil Insects from the Devonian of New Brunswick, by Dr. J. W. Dawson (one plate); W. G. Farlow, on the Gymnosporangia (Cedar Apples) of the United States (two plates); Theodore Lyman, on a New Structural Feature, hitherto unknown among Echinodermata, found in Deep Sea Ophiurans (two plates); W. K. Brooks, the Development of the Squid (*Loligo pealii*, Les.), three plates; A. S. Packard, jun., the Anatomy, Histology, and Embryology, of *Limulus polyphemus* (seven plates); Edward Burgess, Contributions to the Anatomy of *Danais archippus*, Fab. (two plates); Saml. F. Clarke, the Development of a Double-Headed Vertebrate (one plate); C. S. Minot, Studies on the Tongues of Birds and Reptiles (one plate); Edward S. Morse, on the Identity of the Ascending Process of the Astragalus in Birds with the Intermedium (one plate); Lucien Carr, on the Crania of New England Indians (two plates); William James, the Feeling of Effort.

THE PHYSIOGNOMY OF CONSUMPTION[1]

THE idea that a certain type of face indicates a tendency to certain diseases is not only widely diffused in the medical profession, but among the public at large, as is shown by the frequent occurrence of such phrases as "consumptive-looking," and "apoplectic-looking." With a view to ascertaining how far these generally-entertained ideas are true, and of substituting for mere personal impressions the test of exact and unprejudiced investigation, the authors of this paper have made a number of observations by the method of composite portraiture, already described by Mr. Galton in NATURE. The countenance which is supposed to indicate a tendency to phthisis or

[1] "An Inquiry into the Physiognomy of Phthisis, by the Method of Composite Portraiture." By Francis Galton, F.R.S., and F. A. Mahomed, M.D.

consumption, is one of the best marked and most commonly recognised. The authors have begun with this disease, and at present have limited themselves to it. A large number of portraits of phthisical patients were first taken, and were then grouped into composites, clinical facts being first taken as guides for grouping. Thus, cases of advanced disease were grouped first, but they gave no result beyond that of well-marked emaciation. Cases grouped according to the rapidity of their course also yielded no characteristic type, nor was anything very definite at first obtained from those in whom the hereditary taint was strong, but on further investigation this last group of hereditary cases was found to fall into two main divisions, not separated by any abrupt line of demarcation. In the first division the faces were broad, with coarse, blunted, and thickened features; while in the second the faces were thin, narrow, ovoid, with thin, softened, and narrow features. These two groups correspond to the two types well recognised by physicians as strumous and tubercular. On comparing the phthisical with non-phthisical cases, however, it was found that the percentage of narrow ovoids was almost exactly the same in the phthisical and non-phthisical patients. Although the authors do not say so, we may perhaps be justified in regarding these two types of face as possibly racial. Their results lend no countenance to the belief that any special type of face predominates among phthisical patients, nor to the generally entertained opinion that the narrow ovoid tubercular face is more common in phthisis than in other diseases. Whether it is more common than among the rest of the healthy population, they cannot at present say. In comparing composites, both of the broad faces and of the narrow ovoid faces in phthisical and non-phthisical patients, they found that in each case the phthisical patients presented a more delicate form of each type, with finer features, a lighter lower jaw, and an altogether narrower face. Although their conclusions seem to indicate that there is no foundation for the belief that persons possessing certain physical characteristics are especially liable to tubercular disease, yet it may hereafter be proved that some explanation of the doctrine may be found in the course of the disease when it attacks such persons.

Thus the delicately-organised individuals called "tubercular," and characterised by their "narrow ovoid" faces, have been compared with horses and cattle who have been what is called "over-bred"; such animals are described as having too much nerve and too little bone and muscle; they have no "staying power," and readily "knock up." So these delicately-formed individuals are less able to stand the strain of disease and are more liable to its attacks than their more robustly-built fellows. Again, if it be true, as frequently asserted, that those having the features called "strumous" probably inherit a more or less diluted syphilitic taint, it is not surprising that they should be especially liable to inflammatory changes of a low type, and that disease in them should be readily amenable to treatment, especially by mercury, a result commonly seen in the so-called "strumous" diseases of children and often in those of adults."

This paper opens quite a new field of inquiry which is of great interest, and is likely to lead to important practical results.

JOSEPH DECAISNE

By the somewhat unexpected death of Prof. Decaisne, one of the most familiar names disappears from the scientific world of France. Although so inseparably associated with Paris Decaisne was by birth a Belgian, having been born in Brussels in 1809. His brother, still living, rose to the position of Inspector-General of the Army Medical Service of Belgium. When quite a young man Joseph Decaisne entered the service of the Jardin des Plantes at Paris in the position of a gardener. The venerable institution with which for the rest of his life he was associated is very different from a mere pleasure-ground, and it would be a mistake to suppose that the starting-point in Decaisne's career implied anything more than rising from the lowest rank in an establishment which in every detail is nothing if not scientific. In 1840 he was attached to the Herbarium as *Aide naturaliste*, finally returning to the Garden as *Professeur de Culture* and Director in succession to Mirbel.

From Mirbel to the present day is, measured by the rate of progress in botanical science, a tolerably vast leap. Decaisne published his first paper in 1831, and the half century which has since elapsed covers our whole modern knowledge of the histology and morphology of plants. The familiar demonstrations of our biological class-rooms already seem a little hackneyed. Yet they deal with structures and phenomena which, when the distinguished botanist who was buried last week first began to work, were things undreamed of.

Decaisne at a very early period turned his attention to the serious study of algæ, and it is perhaps in connection with this group that he has left his most indelible mark in botanical history. In 1841 he showed once for all that the *Polypères calcifères* of Lamouroux, were not merely *Algæ*, but that the affinities of the diverse types which they comprised could be determined with some certainty. This was a piece of work which may be compared in its way to Mr. Moseley's discovery of the alcyonarian structure of *Heliopora*. The conclusion to which he arrived was not a happy guess, but was based on a laborious examination of the whole class of *Algæ*, with the object of arranging their chaotic assemblage on a basis approaching as nearly as possible to a natural classification. The results are given in an elaborate paper published in 1842. The divisions proposed are not essentially very different from those which are generally accepted at the present day. And they were really more natural than the subsequent but far more artificial classification proposed by Harvey, which has long held its ground in this country. In this particular line Decaisne himself did little more. But in scientific history a man's true position and influence is often most inadequately measured by the actual bulk of his published papers. Decaisne really founded the French School of Algology, the results of which will always be the fundamental memoirs in this branch of morphology. In 1839 Thuret came to Paris, and received from Decaisne instruction in the rudiments of botany. A master will generally infect a competent pupil with his own special enthusiasm, and it is easy to read the secret of Thuret's own splendid scientific career. Decaisne and Thuret began to work together on *Fucus*, which they procured from the fish market of Paris. They soon found, however, it necessary to visit the coast to carry on their observations, the result of which was published in 1844, in a joint paper, in which they first accurately described the antherozoids, assigning them their true function, and gave an account of the beautiful process of division of the primary oosphere in some of the species. After Decaisne's appointment to the direction of the Jardin des Plantes, Thuret carried on his algological work for a time alone, ultimately associating himself with Dr. Bornet, who is happily still living, and occupied with the gradual publication of their joint and classical work.

From the time of Decaisne's appointment to the direction of the Jardin des Plantes he in fact devoted himself heart and soul with scrupulous conscientiousness to the field of work assigned to him. The Jardin des Plantes deals not merely with plants in their feral, but also in their cultivated state. The mere routine duties of his post were onerous beyond belief. The occupants of French administrative scientific posts have no sinecure. They are at the beck and call of the State in all that relates to their subject, and no small farmer in France in doubt as to the name of a pear, or how to manage an intractable graft would hesitate to apply to the *Professeur de Culture* on the subject. It was curious to turn from the bustle of the Parisian streets into the country-town like repose of the Rue Cuvier, where Decaisne was almost always to be found at work in his small red-tiled study lined with books, and ever delighted with urbane and old-fashioned courtesy to do the honours of the establishment. In the work of his latter life there was little room for epoch-making discovery. But his splendid "Jardin Fruitier du Muséum" is a monument of patient labour on the cultivated forms of fruit-plants elaborated in the thorough spirit of the naturalist; and its value will, in a scientific point of view gain with time when the races figured and described in it are supplanted and lost. Students of the future will turn to Decaisne's laborious pages to compare the stages of variation which he has permanently recorded. In much other work of this class he had the collaboration of his friend Naudin, now director of the botanical station at Thuret's country seat at Antibes, which his heirs presented to the French Government.

In the other side of the work of the Jardin des Plantes Decaisne was no less industrious. With minute scrupulosity he was always occupied with the elaboration of careful descriptions of new and interesting genera and species of plants, and the pages of his great "Traité générale de Botanique" (published with Le Maout, but of which the great bulk is based on Decaisne's life-long studies), are everywhere enriched with the results of his dissections. Of the first edition of this admirable survey of the vegetable kingdom an English translation by the late Mrs. Hooker, edited by Sir Joseph Hooker, was published in this country. He published at frequent intervals through his long life much excellent systematic work of a more detailed kind.

Decaisne's turn of mind was essentially precise and matter-of-fact. Perhaps for this reason the doctrines of evolution which in England and in Germany have given a new impulse to biological study, had little interest for him. He would triumphantly show crops of a cruciferous plant raised in front of the physiological laboratory under wire-gauze for many successive years. "There is no departure," he would say, "so far from the specific type," and beyond this kind of evidence he did not seem to care to go. Not that his mind was wanting in flexibility to new deas; he warmly supported the investigations made by Bornet in confirmation of Schwendener's theory as to the nature of lichens—a subject on which most persons accustomed to the view that they are autonomous organisms, feel almost as strongly as if they were possessors of a vested interest menaced by Act of Parliament.

Decaisne was long associated with Brongniart in editing the botanical series of the *Annales des Sciences Naturelles*, and on his death became sole editor. In 1877 he was elected a Foreign Member of the Royal Society. He was unmarried, and to his devoted friend Bornet fell the melancholy lot of watching his last moments and closing his eyes.

W. T. THISELTON DYER

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

VI.

14. THE GORAL (*Nemorhædus goral*).—The "Goral," or "Gooral" of the Himalayan sportsmen is one of the groups of Goat-like or "Mountain" Antelopes, of which we have previously had an example in the Japanese Goat-Antelope (*Capricornis crispa*) figured in a previous article (NATURE, vol. xxiii. p. 488), but is slightly divergent in form, and in some respects perhaps more nearly allied to our familiar Chamois of the Alps and Apennines. In its general habit, as Dr. Jerdon tells us, the Goral is very caprine in appearance; the back is somewhat arched, and the limbs are stout and moderately long, which renders it well adapted both for climbing and jumping. The Goral inhabits the whole range of Himalayas from Bhotan and Sikim to Kashmir, at a range varying from a little above 3000 to nearly 8000 feet, though most common at about 5000 or 6000 feet. It is also found in the Sewalik Hills. According to Capt. Kinloch it is the least wild of all the Himalayan game-animals, and may often be seen in the immediate neighbourhood of the large hill-stations of Simla, Mussourie, and Nynee Tal. Its favourite haunts, we are told by the same distinguished sportsman, are the valleys of the Ganges and the Jumna and their tributaries; in the province of Chamba, north of Sikim, they are said to be particularly numerous.

Gorals in their native wilds are not truly gregarious, but are either met with in small parties of three or four, or in pairs. Their special resorts are steep rocky hills thinly sprinkled with forest, where they lie concealed in the daytime, and come out to feed in the morning and evening. Where the ground is much broken, Capt. Kinloch informs us, they are not difficult to stalk, and when at all plentiful afford good sport, and are capital objects of pursuit to the young sportsmen who may not be up to the "*grande chasse*" of the Himalayan Ibex.

Our figure (Fig. 14) represents a young male of this species, which was received from Calcutta by the Zoological Society in March, 1881, and is the first Goral that has been exhibited in their gardens.

15. The Burrhel Sheep (*Ovis burrhel*).—The various species of wild sheep are widely distributed over the mountain-chains of the Palæarctic region, one only—the Big-horn of the Rocky Mountains—being found in America. In Europe the only Sheep now existing in a wild state is confined to the islands of Sardinia and Corsica, where the Moufflon (*Ovis musimon*) occurs under two slightly different forms. But in our new possession of Cyprus a second species (*Ovis cyprius*) occurs. and a closely allied form (*O. gmelini*) is found in the mountains of Asia Minor. The various mountain-groups of Central Asia are tenanted each by its own species of wild sheep (*Ovis karelini*, *O. poli*, *O. argali*, &c.), in some of which the horns attain a prodigious development, and, in order to render them able to support such a burden, the animals themselves are necessarily of enormous size and strength. In Kamschatka the representative of the sheep is the fine *O. nivicola* of Eschscholtz, discovered during Kotzebue's second expedition, which, as might have been naturally expected, comes nearest to the American "Bighorn."

On the confines of India four or five species of wild sheep come within the grasp of the collector and sportsman, though the genus has in fact nothing to do with the true Indian fauna. One of these (*Ovis cycloceros*) is an inhabitant of the Salt-range of the Punjab It is replaced in Afghanistan by the recently described *O. blanfordi*, and in Cashmere by Vigne's wild sheep (*O. vignei*). On the main chain of the Himalayas two fine species of wild sheep attract the attention of our sporting fellow-countrymen whose destinies take them to India. One of these, commonly called the Ammon, though not strictly entitled to that appellation,[1] is confined to the undulating highlands of Tibet, the other, although also an inhabitant of lofty ranges, occurs in many parts of the southern slopes of the Himalayas. This is the Burrhel, or Nahoor (*Ovis burrhel*), of which we now give a figure (Fig. 15), from two young examples recently added to the Zoological Society's collection.

The Burrhel, or blue wild sheep, Dr. Jerdon tells us,

[1] Continued from p. 298.

[1] The *Ovis ammon* of Linnæus is the same as *O. argali*: the proper name for the Himalayan "Ammon" seems to be *O. hodgsoni*, Blyth.

is found from Sikim nearly to Simla, but does not extend further west than the valley of the Sutlej, its place being there taken by *Ovis vignei*. The Burrhel is found on this side of the great snowy range at the head of the Tonse River, in the Buspa Valley, near the source of the Ganges, and still more abundantly eastward in Kumaon and Gurhwal, in the ranges between the Pindar and Bhagirutty rivers. It occurs only at great elevations,

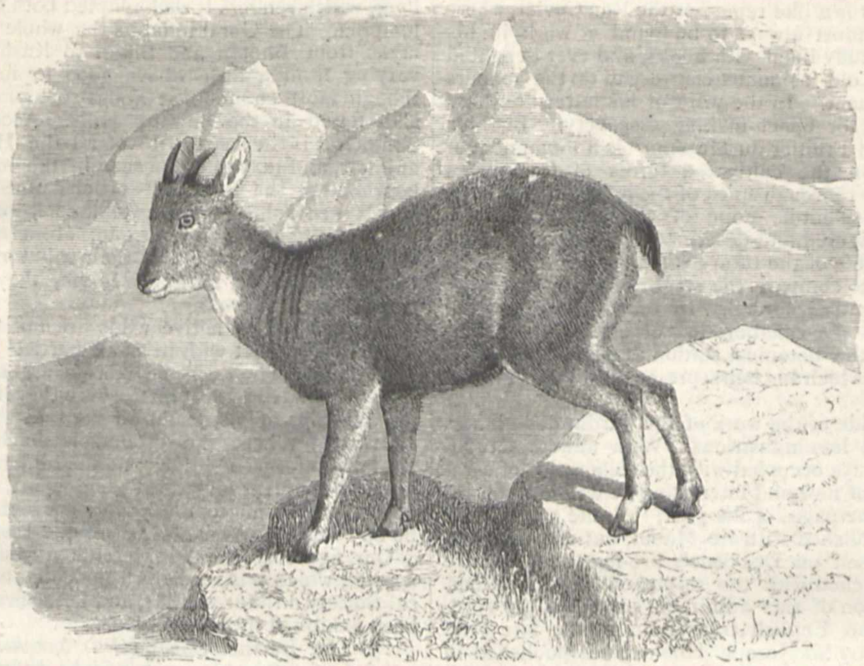

Fig. 14.—The Goral.

from the limits of forest to the extreme limits upwards of vegetation, in summer generally keeping to the tops of the hills, and even in winter rarely descending below the forests.

In a state of nature the Burrhel prefers grassy slopes to rocky ground, and associates in flocks of various sizes, from four or five, to fifty, or even a hundred.

Capt. Kinloch, in his excellent account of the "Game

Fig. 15.—The Burrhel Sheep.

Animals of Tibet and the North-West," tells us that the best Burrhel-shooting is to be obtained in the Valley of Leptel, beyond the Millum Pass, and that of Spiti between the Manerung and Parungla Passes, and gives us an exciting account of his adventures in pursuit of these splendid animals in the former locality.

16. The Esquerzo (*Ceratophrys ornata*).—The glass cases which held the various species of insects in the

Zoological Society's Insect-house during the past summer have been partially devoted during the winter months to the use of small reptiles and batrachians, for which they seem to be in every respect well adapted. Most of these animals, although shy and retiring in their habits, enjoy the warmth of the sun's rays and thrive excellently in their new habitations.

Amongst the batrachians thus exhibited are several species of gigantic size when compared with their puny representatives in this country, such as the Agua Toad (*Bufo agua*) of Brazil and the Ocellated Bladder-Frog (*Cystignathus ocellatus*) of Buenos Ayres. But by far the most remarkable of these forms in the series is the Adorned Ceratophrys, or "Esquerzo" of the natives of the Argentine Republic—a large toad of brilliant colours and extraordinary form, of which a figure (Fig 16) is now given, taken from a water-colour sketch prepared by Mr. Ernest Griset.

The Esquerzo was discovered by Mr. Darwin during the celebrated voyage of H.M.S. *Beagle*, and first described by the late Prof. Bell in the "Zoology of the Voyage of the *Beagle*." This monster inhabits the pampas of Buenos Ayres, and is said to feed chiefly on its smaller brethren of the same class. Mr. Ernest William White, F.Z.S., to whom the Society is indebted for one of the two specimens now in the Gardens,

FIG. 16.—The Esquerzo, or Barking Toad.

specially mentions it in his lately-published "Cameos from the Silver-Land" as one of the characteristic forms of the grassy plains of the Argentine Republic. "In the damp grass," he says, may often be perceived the leering eyes and mottled black and green body of the huge Esquerzo (*Ceratophrys ornata*), whose gaping mouth crammed with the body of an unfortunate sapo (toad), and surmounted by threatening horns, inspires terror. This said Esquerzo bears an awfully spiteful character, and is credited with the deaths of many children. His appearance is certainly against him, but he is otherwise perfectly harmless."

The Esquerzo seems to thrive equally well on English frogs as on the toads of Buenos Ayres, and does well in captivity. It is not, however, a very good object of exhibition, as, if left to its own devices, it hollows out a cavity to fit its body into the turf with which it is supplied, and leaves only the top of its head and projecting eyebrows barely visible. If harried out of its retreat for the examination of some curious visitor, it expands its body into almost a circular shape, and bites fiercely at any small object presented to it. At the same time it gives vent to its injured feelings in an angry whine, something like the snarl of a puppy, which has caused it to be known amongst the frequenters of the Gardens as the "Barking Toad."

NOTES

WE are glad to notice that a decided step has been taken towards the preservation of our ancient monuments. Sir John Lubbock has succeeded in getting the following resolution adopted in the House of Commons:—"That pending the introduction of a general measure dealing with the ancient monuments of the kingdom, and in order as far as possible to protect them from further injury, it is desirable that Her Majesty's Government should appoint one or more inspectors with authority to inspect and report upon such ancient monuments." Mr. Shaw-Lefevre, on the part of the Government, assented to the motion, and added that it was their intention to bring in a Bill dealing with the subject in which the hon. baronet took so much interest. Thus Sir John Lubbock's determined perseverance in this important matter is likely at last to meet its reward.

IN deference to the strong feeling which evidently exists on the matter, the Zoological Society may be induced, if not too late, to reconsider the bargain they have made with Mr. Barnum for the disposal of their great African elephant, Jumbo, the universal pet of children. He has, we understand, been sold for 2000*l.*, but has shown so obstinate and touching a determination not to leave the Gardens which have been his home since a baby that it seems cruel to force him to do so. The general feeling is expressed in a letter which we print to-day, and during the last few days there have been numerous remonstrances on the subject in the press; one correspondent suggests that if the Society is really in want of the money, the public would be only too glad to raise it to keep Jumbo. One reason given for parting with the animal is the uncertainty of his temper; but we doubt if there is any real ground for this excuse, and we hope it is not too late to prevent the children breaking their hearts for the loss of their favourite.

IN vol. xxiii. p. 561, we gave an illustration of the new Etna Observatory, and stated that it would probably be completed by 1882. Signor V. Tedeschi writes from Catania to the *Daily News* that the Observatory has just been finished. Signor Tedeschi points out the exceptional advantages possessed by the Observatory from its lofty position for astronomical and spectroscopical observations. "These advantages," he states, "induced the Municipality of Catania, at whose expense the observatory was constructed, to aim at its being an international station, and so they added to the observatory three large bedrooms, a dining-room, and kitchen for the use of such foreign men of science as desire to remain there for some time, and the telescope is furnished with a movable iron tube, the length and aperture of which can be modified at pleasure, so that foreign astronomers can apply the instruments they bring with them. The observatory is built on a little eminence on the side of the central crater of Etna, a position which makes it almost certain that should a stream of lava issue on that side it would divide into two streams and flow harmlessly on each side of the little hill. The building consists of two storeys, the joint height of which is 9 metres, and the base of the edifice occupies a superficial area of 200 square metres. In each storey there is a large circular room surrounded by other chambers destined for different uses. In the centre of the circular room in the lower storey there is a solid pillar to support the great refractor. All the instruments, as well as a fine collection of seismographic and meteorological apparatus are in the upper storey, in the large circular room of which are the telescope and chronometrical apparatus. This room is roofed with a movable iron dome. The observatory on Etna is the highest building in Europe. The observatory on Vesuvius is 619 metres above the level of the sea, the Hospice of the Gotthardt 2075 metres, and that of St. Bernard 2491; while the Etna observatory is at a height of 2942 metres." This observatory will probably render invaluable service to astronomical science as well as to terrestrial physics.

NATAL, we are glad to learn, is going to have an observatory, as will be seen from the following extract from a Grahamstown paper:—"Through the generosity of three well-to-do colonists in Durban we are going to have an observatory at Natal at last. It seems that Mr. Gill, the Astronomer-Royal at the Cape, is now on a visit to the port, and noticing that Durban is a favourable site for observing the transit of Venus, he mentioned the circumstance to Mr. Henry Escombe, who at once offered to give a first-rate equatorial telescope, costing 450*l*. The Town Council granted a site for the observatory, and Mr. W. Randles and Mr. Greenacre, two Durban merchants, undertook to defray the cost of the building (300*l*. to 400*l*.) between them." A correspondent of the *Scotsman* commends this excellent example to the shipowners and landowners of Scotland, whose interests would be specially served by a well-equipped observatory on Ben Nevis.

NINE lectures on the Anatomy, Physiology, and Zoology of the Edentata will be delivered in the theatre of the Royal College of Surgeons, on Mondays, Wednesdays, and Fridays, at 4 o'clock, commencing on Monday, February 27, by Prof. W. H. Flower, LL.D., F.R.C.S. The following is a programme of the course:—General characters of the order: Family *Bradypodidæ*—the Sloths; *Megatherium* and other great extinct Ground Sloths of America; Family *Myrmecophagidæ*—the true Anteaters; Family *Dasypodidæ*—the Armadillos; *Glyptodon*—and other extinct Armadillo-like animals; Family *Manidæ*—the Pangolins or Scaly Anteaters or Aard-varks; the extinct Edentata of the Old World; Classification of Edentata and relation to other groups.

IN connection with the International Electric Exhibition at the Crystal Palace, arrangements have been made with Prof. S. P. Thompson, of University College, Bristol, to give the following course of lectures:—1. Electric Currents—What are they? (February 22); 2. Electric Currents—How to make them by Steam? (March 1); 3. Electric Arc Lights (March 8); 4. Electric Incandescent Lamps (March 15), on each evening at 8 p.m. The lectures will be illustrated by diagrams in the magic lantern, by experiments on a large scale, and by experiments in the magic lantern. This is a praiseworthy step on the part of the directors, and we hope it will meet with encouragement.

AT the meeting of the Essex Field Club, to be held at Buckhurst Hill, next Saturday, February 25, the desirability of directing public attention to the pressing necessity which exists that some means should be adopted for the protection of our native animals and birds from wanton destruction by gamekeepers and others, will be brought before the Club by Sir Fowell Buxton, Bart. (Verderer of Epping Forest). Zoologists and lovers of Nature generally, whether Members of the Society or not, are earnestly requested to attend, and take part in the discussion.

ONE of the most recent additions to Chinese literature, according to the *China Review*, is a translation of Gray's well-known work on Anatomy. The translator, the late Dr. Osgood, is said to have succeeded in the task of giving Chinese names to the multifarious and minute structures which constitute the human body. The difficulty of this will be obvious, when it is remembered that the Chinese know hardly anything of anatomy, or of the functions of the various organs of the body. The only work up to this in Chinese on the subject was a very elementary one, published nearly twenty years ago, by a European physician.

A CHAIN of meridian distances, extending from Vladivostok to Madras, has been telegraphically measured during the past year by Lieut.-Commanders Green and Davis, and Lieut. Norris of the U.S. Navy. The stations occupied and determined were Vladivostok, Nagasaki, Yokohama, Shanghai, Amoy, Hongkong, Manila, Saigon, Singapore, and Madras. The exact longitudes of the two terminal stations had been previously established by Russian and English officers, but the positions of the intermediate stations from which nearly all the longitudes of China and Japan have been chronometrically measured have always been seriously in doubt.

ATTENTION continues to be bestowed on the search for new elements, and the classification of those which have been recently discovered. According to Phipson (*Compt. rendus*, xciii. 317), a specimen of zinc pigment examined by him contained about 4 per cent. of a new metal, to which, because of the action of light upon its salts, he gives the name *Actinium*. Mendelejeff (*Berichte*, xiv. 2821) shows that the recently discovered cerite metal Ytterbium finds its natural place in his scheme of classifying the elements according to their atomic weights. Two new chlorides of Gallium are described by L. de Boisbaudran (*Compt. rend.* xciii. 294), and determinations of the density of the vapour of gallic chloride have confirmed the number 69·9 as the atomic weight of Gallium.

CHEMISTS are now paying much attention to the study of chemical changes, and they are beginning to venture on a few generalisations. Several Russian chemists have recently made important advances, notably Kajander, who considers the velocity of the changes which proceed when metals are dissolved by various acids (*Berichte*, xiv. 2666), and finds that the rate of solution varies, according to the strength of acid, in the same way as the electric conductivity of the acid varies. Menschutkin (*J. Pract. Chem.*, xxiv. 49) continues his researches into the rate of etherification of various alcohols, and succeeds in tracing definite connections between this rate and the "molecular structure" of the various alcohols examined. Tribe (*Chem. News*, xliv. 185) attempts to measure the relative affinities between the constituents of electrolytes, by determining the magnitudes of the spaces between the boundaries of electro-deposits on metallic plates.

No. 2, Segundo anno (1 Fev. 1882), of the *Revista da Sociedade de Instrucção do Porto* (published at Oporto) commences with the first instalment of a "Catalogue des Insectes du Portugal," by Prof. M. P. d'Oliveira of Coimbra, printed in French. The somewhat lengthy introduction brings to light the existence in Portugal of more entomologists than most of us suspected, according to the list of persons thanked by the author for the assistance they have rendered him. The *Coleoptera* are commenced, but do not at present extend beyond the genus *Omophron* in the *Carabidæ*.

The temperature of the southern hemisphere has lately been investigated by Dr. Hann with the aid of recent observations of temperature in high southern latitudes, especially those made during the Venus transit in 1874. For mean temperature of the whole hemisphere he obtains 15°·4 C., and as that of the northern hemisphere was estimated by Ferrel to be 15°·3 C., it is very probable that both hemispheres have the same mean temperature. Dr. Hann, however, also shows that between 40° and 45° south latitude the southern hemisphere becomes warmer than the northern in the same latitude, and that a difference between the two persists at least to the confines of the hypothetical antarctic continent. The results of the projected antarctic scientific expedition this year, which will include a whole year's meteorological and magnetic observations in high latitudes, will do much, doubtless, to clear up the subject of temperatures. Dr. Hann urges the usefulness of a careful determination of ground-temperatures on islands (McDonald's Islands, Auckland, Maquarie, South Orkney, &c.).

Prof. Heim, of Zurich, has visited Fettan, the village in the Grisons which is being swallowed up by the ancient moraine on which it is built. He ascribes the phenomenon to the movement of underground waters, and considers that the perils may be averted by certain engineering operations, which will probably be executed under his superintendence.

Prof. Naudin has observed a lowering of the level of the Mediterranean at Antibes (Alpes maritimes) which amounts to 30 centimetres. He believes the reason to be the rising of the coast through volcanic influences. The inhabitants of the coast ascribe the phenomenon to the recent prolonged dry weather. Dr. Faye of Paris has also studied the subject, and according to his opinion it is the recent high atmospheric pressure which causes the recession of the sea in that locality.

Dr. Max Buchner, the explorer of the Lunda district, West Africa, has reported on his recent journey to the Berlin "Gesellschaft für Erdkunde." On December 10, 1878, he had started on his journey from St. Paul de Loanda to Malange (lat. 9° 32′ S., long. 16° 38′ E.). There he waited for the dry season, and by the end of July, 1879, he continued his journey with a caravan numbering 160 people. Without much trouble he passed through the land of the Songo, crossed the Quango and numerous other rivers, and penetrated to the residence of the Kioko chief, Mona Kissenge, who took him to be a merchant and wanted to stop him. Dr. Buchner managed to overcome all hindrance, and reached Kabongo (lat. 9° 30′ S., long. 21° E.), entering Mussumba, the residence of Muati Yambo, the Lunda chief, on December 11, 1879. Mussumba numbers 2000 inhabitants, and is the Eldorado of the slave trade. Muati Yambo and Queen Lukukesse, who reigns independently, received Dr. Buchner in solemn audience, but as the chief also believed him to be a merchant, he did not permit the traveller to proceed further into districts whence he himself purchases slaves and ivory, in which he does a large trade. Dr. Buchner remained at Mussumba for six months and then pretended to return. Near the Kassai River he turned to the north in order to penetrate into the unknown districts by the land of the Tukungo. This attempt however failed. Two other attempts to reach Kilua (Muata Kumpana's residence) also failed through the positive resistance of the inhabitants, and the mutiny of his guides and carriers. Thus he was compelled to return to Malansh.

The deaths are announced of M. Antoine Alexandre Brutus Bussy, member of the Academy of Sciences, an eminent chemist and physicist, at Marseilles, on February 4, aged eighty-eight; of Dr. Franz Schlegel, director of the Breslau Zoological Gardens, on February 7; of Frederick Warrington of Tripoli, who for over fifty years hospitably received and liberally assisted all African travellers who started from Tripoli for the interior, on January 26, aged seventy-four; of Herr Blasius Kleciak, a "Commisar" on the Dalmatian island of Lesina, and well-known as a conchologist, on January 12 last; of Dr. Simon Syrski, Professor of Zoology at Lemberg University, an eminent ichthyologist, on January 14, aged fifty-one; of Dr. F. J. Stamkart, formerly Professor at the Polytechnical School of Delft, Holland, an eminent mathematician, who died recently at Delft, aged seventy-seven; of M. Felix Billet, Dean of Dijon University, corresponding member of the Academy of Sciences, and author of numerous physical works and treatises, who died at Dijon on January 29, aged seventy-four.

A company has been formed at Palermo with the object of constructing a railway to the summit of Mount Etna, in imitation of the Vesuvius Railway.

The International Polar Commission has issued the first number of a special publication, edited by the President, Dr. Wild, to appear in regular numbers, for the purpose of insuring the rapid and continuous dissemination of intelligence relating to the International Polar Expedition. This number gives a sketch of the history of the scheme, the programme of observation, and a brief statement of what has been done.

The German Government has appointed a Commission consisting of Prof. Neumayer, Capt. von Schleinitz, Drs. Nachtigal, Dörgens, and Ernst Hermann, with the object of making the necessary preparations for erecting the German Meteorological station in the North Polar Region in conjunction with the other States participating in the International Polar Research recently planned. The Commission will meet at Hamburg during the present month.

Preparations for a North Polar Expedition which is to start during the present year are being actively made in Holland. The lead is taken by Prof. Buys Ballot of Utrecht. The Second Chamber has granted a subsidy of 30,000 florins, and a committee has been formed at Utrecht which intends to raise the additional funds that are necessary by means of public subscriptions.

The Russian Geographical Society have resolved to fit out an exploring expedition to Novaya Zemlya, and to give the command to Andreieff.

The first annual general meeting of the London Sanitary Protection Association is fixed for Saturday next. Prof. Huxley and Prof. Fleeming Jenkin will speak on the progress of the

Association, also Dr. Acland, Dr. Andrew Clark, Dr. Lauder Brunton, &c. It seems that of the 192 members of the Association 22 are medical men.

WE see from a report in the *British Guiana Colonist*, that the Museum in Georgetown, belonging to the Royal Agricultural and Commercial Society, is making excellent progress. Mr. Im Thurn, who has already done good work for science in the Colony, has returned to take charge of the Museum, and the reforms he proposes to introduce, with the approval of the Society, promise to make the Museum one of real scientific value, as well as of practical importance in connection with the development of the resources and industry of the Colony. Mr. Im Thurn is authorised by the Society to bring out a skilled German taxidermist, so that in time the Museum will probably have a valuable collection of birds.

THE Italian Government has published some interesting facts relating to the state of the public instruction in that country. The recent law on primary schools has been applied to 7533 communes of the 8276 existing in the Peninsula and surrounding islands. The number of public teachers in these schools is 41,000, viz. 20,700 males and 20,300 females. Out of a population of 26,801,194 the pupils are 1,048,000 males and 853,429 females, for a yearly expense of 31,000,000 francs —26,000,000 for wages and 5,000,000 for *matériel*. There are besides 7422 private primary schools with 7422 male and 4444 female teachers, but with 92,228 female and only 63,000 male pupils. There are also in the kingdom 11,161 male evening schools for adults and 472 female, the first with 439,624 pupils, and the other with 16,063. Females largely preponderate in Sunday schools; there are only 592 schools and 21,914 pupils for male Sunday instruction, and 5979 with 191,245 for females.

EARTHQUAKES in the northern alluvial districts of Europe are certainly of rare occurrence. Reports from many localities, however, prove that an earthquake was observed in North Schleswig and South Jutland on Jan. 14, between 10 and 11 p.m. The phenomenon was observed at Hadersleben, Kolding, Klitland, Ringkjöbing, &c. Early in January numerous shocks were observed upon the island of Chios. The western part of the island continues sinking deeper and deeper, so that its disappearance below sea level is shortly expected.

M. UJFALVY has returned from his journey to the Western Himalaya district, undertaken under the auspices of the French Government. This was the fourth scientific expedition undertaken by M. Ujfalvy. He again brings large ethnographical collections, also numerous anthropological specimens, skulls, samples of hair, and measurements.

FROM the programme of the Second German "Geographentag," to be held in Halle on April 12-14, an interesting meeting may be expected. The papers which are to be read are all on subjects of scientific interest, and afford one more proof of the highly scientific conception which Germans have of Geography.

THE "Handbook of Cinchona Culture," by Karl Wessel van Gorkom, formerly Director of the Government Cinchona Plantations in Java, has been translated by Mr. B. D. Jackson, Botanical Secretary of the Linnean Society of London, and will be shortly published by Trübner and Co.

CONFLAGRATIONS have at all times been the plague of Japanese towns. It has been said that Tokio, the capital of Japan, is rebuilt once in every seven years. During the winter of 1880-81 it was calculated that three-tenths of the city was destroyed by fire. Almost the whole commercial quarter, situated in the heart of the town, disappeared, leaving nothing but blackened ruins behind. Each winter a tale of similar desolation comes from almost every town in Japan. Various modes of meeting or preventing calamities of this description have been suggested. A system of national insurance has been proposed; the arrangement of the towns in sections, each surrounded by a large wall, which would confine fires to a single quarter, as in Peking, was mooted last year, but as yet nothing has been done. Expense has generally been the the chief obstacle; but a paper in the last (the 25th) number of the *Mittheilungen der deutschen Gesellschaft für Natur und Völkerkunde Ostasiens*, by Dr. O. Korschelt, a chemist in the employ of the Japanese Government, suggests an economical, and apparently very practicable, way of meeting the difficulty. The paper deals with Japanese soil as a natural cement material. He shows that the usual soils on the plains of Japan, derived from volcanic tufa, closely resemble *puzzolana* and *trass* in composition, and form the basis of an excellent cement. Chemical and mechanical analyses of several of these tufa soils are given; their specific gravity is less than that of any other soils except those containing very large amounts of vegetable matter. Mixed with one-sixth their volume of lime, these soils form excellent cement for building purposes, and the writer points out that by using such materials the Japanese could substitute stone houses for wooden ones in nearly all their provinces in a very simple and economical manner, and thus save to a very large extent the enormous annual waste of substance which occurs through fires. There is no lack of this material; the higher lands of the city of Jedo stand on beds twenty feet in thickness. Referring to the agricultural relations of these soils Dr. Korschelt coincides in the view previously brought forward by Mr. Kinch, that these soils are not by nature chemically rich, at all events in their mineral constituents, but that owing to their physical properties, which in turn are dependent mainly on the large amount of easily decomposable zeolitic silicates they contain, are most admirably adapted to the system of agriculture pursued by the people.

AMONG the papers in the last number of the *Mittheilungen* is one by Dr. Naumann, on the Trias formation in Northern Japan; by Dr. Döderlein on Japanese marine snakes, and the analysis of a fragment of meteorite by Dr. Korschelt.

THE Perthshire Natural History Society have issued Part 1 of the first volume of their *Proceedings*. It is neatly got up and contains abstracts of the various papers read at the meetings, 1880-81, and an account of the excursions for which the Society is so favourably situated.

THE *Ausland* states that M. Raffray, the French Vice-Consul at Massowah, discovered in the Land of the Gallas in the mountains of Oebul (Sabul?), at ten different places, rocks of which the interior was excavated and transformed into places of worship. He is of opinion that these rocky chapels date from the fifth century.

THE 200th anniversary of the birth of Johann Friedrich Boettiger, the inventor of porcelain, was celebrated at his birthplace, Schleiz (Germany), on February 4. The Royal porcelain factory of Meissen sent an artistically designed votive tablet to the civic authorities of Schleiz, which was fixed to the "Rathhaus" of that town on that day.

THE additions to the Zoological Society's Gardens during the past week include a Mule Deer (*Cervus macrotis* ♀) from North America, presented by Judge Caton; a Bauer's Parrakeet (*Platycercus zonarius*) from Australia, presented by Mr. S. Draper; a Common Buzzard (*Buteo vulgaris*), British, presented by Lord Walsingham, F.Z.S.; a Common Raven (*Corvus corax*) from Scotland, presented by Sir George Leith Buchanan, Bart.; an African Elephant (*Elephas africanus* ♂) from Africa, deposited; two Grey headed Love Birds (*Agapornis cana* ♂ ♀) from

Madagascar, a Common Coot (*Fulica atra*), British, a Blaubok (*Cephalophus pygmæus*) from South Africa, three Pluto Monkeys (*Cercopithecus pluto*) from West Africa, purchased; an Axis Deer (*Cervus axis* ♂), born in the Gardens.

THE INFLUENCE OF MATHEMATICS ON THE PROGRESS OF PHYSICS[1]

IN discussing the value of a given study, a lecturer is by common consent allowed—sometimes even in private duty bound—to exaggerate the importance of his subject, and to present it to his audience enlarged, as it were, through the magnifying power of a projecting lens, so that the details with which he has necessarily to deal may be brought into more prominent view. In an introductory lecture such as it is my duty to give to-day, the speaker need the less feel any scruples in following the usual custom, as different subjects are treated of in successive years, and the hearer may, after the lapse of a short cycle, strike a pretty fair balance between the various branches which have successively been brought before him. But although I might have felt tempted to-day to insist on the advantages of Applied Mathematics as a separate subject not only worthy of study, but second to none in interest and importance, and though I feel no doubt you would have accorded to me the indulgence which everybody requires who endeavours to lay an abnormal stress on the merits of a single branch of human knowledge, I prefer to found the claims of the subject which I have the honour to represent in this college, not so much on its intrinsic value as on the influence it has had on the progress of other sciences. For no subject can stand by itself, and the utility of each must be measured by the part it takes in the play of the acting and reacting forces which weave together all sciences into a common web.

The growing importance of mathematics as an aid to the study of all sciences is daily becoming more apparent, and it may indeed be questioned whether at the present time we can speak of physics as apart from applied mathematics. Riemann's opinion that a *science* of physics only exists since the invention of differential equations is intelligible; but however close the connection between physics and mathematics may be or may become, their growth in the earlier stages has been altogether independent. Galileo may be said to have been the founder of mathematical physics, and amongst his successors have been many who showed a greater inclination towards pure mathematics than towards physics proper. On the other hand, we can trace back the ancestry of our experimental physicist and that of our modern popular books on science to the Middle Ages, where we reach J. Baptista Porta and his books on natural magic. Even eighty years ago the fullest account of the state of experimental science was to be found in "Wiegler's Natürliche Magie," a book of twenty volumes, in which scientific experiments and conjurers' tricks are alternately described. But since the beginning of this century the importance of the mathematical treatment of purely physical subjects has steadily grown, and fifty years ago the two sciences were already sufficiently united to induce the founders of the British Association to join them together into one section. From that time until the present year, when the mass of work necessitated a temporary separation, the experimentalist and the pure mathematician could be seen at the annual meetings listening, or at least appearing to listen, to each other's investigations, and the influence which men of science on these occasions had on each other may be taken to represent roughly the mutual influence of the two sciences themselves; it was substantial, though in great part unconscious. I could not attempt to-day to give you a complete historical survey of the effect which the contact—one might often say the collision—of the two sciences had on the progress of each; even that part of the subject which I have chosen for special consideration is too vast to be successfully confined within the limits of a single lecture, and an incomplete sketch is all I can offer.

The influence of mathematical investigations on physical theories is not restricted to any single stage, but makes itself apparent throughout the whole course of their evolution. Before a theory is even started, the mathematician is often necessary to prepare its way. He has to classify complicated facts in a systematic manner, and working backwards from the phenomena presented by nature, he endeavours to find out which of them are necessary consequences of others, and which of them require independent hypotheses for their explanation. It is in this way that the works of Poisson, Green, Gauss, and of all those who have followed in their footsteps, may be said to have laid the foundation of the theory of magnetism and electricity, although we do not yet as possess any physical notions as to the causes of these phenomena. The true power of mathematics, however, comes into play only when the physical inventor has done his work, and has formed distinct materialistic conceptions which allow themselves to be expressed by mathematical symbols. It is then that the consequences of the theory are to be worked out and tested by experiment. In order to be convinced of the truth of any hypothesis, the scientific world wants quantitative experiments. Numbers form the connecting link between theory and verification, and they always imply mathematical formulæ, however simple these may be. Often two rival theories are on their trial and the mathematician is supposed to find out where their conclusions differ and where crucial experiments are most likely to decide definitely between them. It is remarkable, however, how much more often physical or even metaphysical considerations have decided between two theories than arguments derived from mathematical reasoning. So-called crucial experiments, as a rule, come either too early or too late. Sir Humphry Davy's experiment was absolutely conclusive against the corpuscular theory of heat, but scientific ideas were not ripe yet for the discovery, and his experiment had no marked effect on the progress of science. The crucial experiment here did not involve any mathematical deductions; it is otherwise with that which might have decided between the two theories of light. According to the corpuscular theory, light travels more quickly in water than in air; according to the undulatory theory, the passage through water is the slower, and this distinction is founded on the necessity to account mathematically for the laws of refraction. But when Foucault actually made the experiment, and gave a death-blow to the corpuscular theory, that theory was already dead. There was then only one scientific man of note left who still viewed the undulatory theory with suspicion, and his suspicions were not allayed by the crucial experiment. But if mathematical deductions have not decided as often as they might have done between two rival theories, they have constantly strengthened and confirmed our belief in physical hypotheses by inventing new cases which might test the theory, and which might, if experiment snpported the mathematical deduction, establish it on a yet firmer basis.

The most important of all the functions of mathematical physics, however, and perhaps the only one through which mathematics has had an unmitigated beneficial influence on the progress of physics is derived from its power to work out to their last consequences the assumptions and hypotheses of the experimentalist. All our theories are necessarily incomplete, for they must be general in order to avoid insurmountable difficulties. It is for the mathematician to find out how far experimental confirmation can be pushed, and where a new hypothesis is necessary. Facts apparently unconnected are found to have their origin in a common source, and often only a mathematician can trace their connection. It is here that the pure experimentalist most often fails. A new experiment gives results to him unexpected, and he is tempted to invent a new theory to account for a fact which may only be a remote consequence of a long-established truth. Many examples might be given to show how mathematics often finds a connection unsuspected by the pure experimentalist, but one may be sufficient. A ray of light passing through heavy glass placed in a magnetic field, in the direction of the lines of force, is doubly refracted as it comes out. To none but a mathematician is it clear that this is only a direct consequence of Faraday's discovery that the magnet turns the plane of polarisation of the ray on its passage through the glass. Happily this fact was first worked out theoretically; had it been otherwise, we should have heard much of the power of the magnet to produce double refraction.

In addition to the many services actually rendered by mathematical treatment, the mere attempt to put physical theories into a form fit for such a treatment has often been invaluable in clearing the theory of all unnecessary appendages and presenting it in the simple purity which may bring its hidden failings to light, or may suggest valuable generalisations. Instead of dealing, however, in a general manner with the various ways in which mathematics have been useful in the prosecution of physical investigations, it will be better to give a short account of the growth of

[1] A lecture introductory to the Session 1881-82 of Owens College, Manchester, by Arthur Schuster, Ph.D., F.R.S., Professor of Applied Mathematics.

some of our physical theories, and to illustrate the subject of this discourse by a few digressions suggested by the historical development.

As a first example I chose the progress of the undulatory theory of light. There is no other branch of physics in which the power of mathematics has been more successfully shown, nor is there one which shows the relations of experimental to mathematical physics in a truer light. At first we had experimental facts ahead of theoretical explanations; then we had the undulatory theory, which placed theory in advance of experiment; and now again a reversal has taken place, and unexplained experiments will remain unexplained until we shall be able to form more definite ideas of the relations between matter and the luminiferous ether.

Huyghens first worked out scientifically the hypothesis that light consisted of the undulations of an all-pervading medium. But as those who adopted the rival theory professed to explain equally well all phenomena which were then generally known, the scientific world preferred to walk in Newton's footsteps, and to reject what they believed to be the complicated and unnecessary assumption of an universal medium. The corpuscular theory could easily explain the ordinary laws of reflection and refraction. Its attempts to explain the colours of thin plates and the fringes of shadows were less successful, but experimental investigations of these phenomena were not sufficiently advanced to bring these facts prominently into view, nor had their true explanation as yet been given. It was only when mathematical analysis was applied to the undulatory theory that its enormous advantages were discovered. Neither of the men to whom we owe the greatest advance which has yet been made in the science of light was a professed mathematician. Young was a medical man, Fresnel was an engineer; nor was the subject, when these men took it up, in a state which would have attracted a mathematician. Conceptions distinctly physical had to be formed, and assumptions not quite satisfactory had to be made. Their chief claim to our gratitude rests, not so much on the mathematical treatment they have given, as on the fact that they left the subject in a state sufficiently advanced to allow mathematicians, even without special physical proclivities, to take it up, extend it, and establish its foundations more firmly than otherwise they could have done.

The different manners in which Young and Fresnel set to work to prove to the scientific world the truth of their favourite hypothesis, and the corresponding difference in their success is especially interesting for the purpose which we had in view. Both men had considerable mathematical ability, and of the two, Young perhaps had the greater inclination towards pure mathematics, yet he avoided wherever he could the use of mathematical symbols, and disdained to bring forward experimental verification for what he considered sufficiently clear without.[1] It is to Young that we owe most of the physical conceptions which have secured a final success for the undulatory theory of light. He was the first to explain the principle of interference both of sound and of light, and he was the first to bring forward the idea of transverse vibrations of the undulations of light. The most diverse phenomena were explained by him, but their easy explanation was a sufficient proof to him of the theory he was defending, and he did not trouble to verify his conclusions by extensive numerical calculations. It thus happened, that although Young was first in the field in furnishing the true explanation of complicated phenomena, Fresnel, applying mathematical analysis to a much greater extent, had a much more potent influence in turning the scale of public opinion in favour of their common theory.

Though Fresnel's first memoir was published fourteen years after Young had established the principle of interference, Young's writings had remained unnoticed by him as well as by the scientific world in general, and Fresnel was surprised and irritated to hear that another had been in the field before him. But everyone must agree that the chief share in securing the final triumph of the wave theory belongs to Fresnel, nor can there be any doubt that this is due to the mathematical calculations which he applied to cases easily verified by experiment. For there is a great fascination in a table with one column headed "calculated," another headed "observed," and a third giving the differences with the decimal point as much to the left as possible. And it is right that such tables should play an important part in the history of science, for whatever the ultimate fate of a partially accepted theory, the one solid legacy which it will leave behind after its death is the array of numbers for which in its successful stage it has given a sufficiently correct account.

Fresnel invented different pieces of apparatus to test Young's simple supposition, independently made by him, that waves may be made mutually to destroy one another by addition, the crest of one wave being superposed on the hollow of another. It is necessary that the waves should originally be derived from a single source of light, yet they must seem to diverge from two different points. The necessary experimental conditions were fulfilled by the ingenious device of reflecting the light from two mirrors slightly inclined to each other. The light diverging from the two images of one source was allowed to cross, and bands alternately luminous and dark were measured at the places where the waves overlapped. A rough micrometer of his own construction served to measure the intervals between the bands at various distances from the mirror, and Fresnel succeeded in obtaining sufficient data to test his theory. It cannot be my purpose to follow Fresnel and to describe all the various devices which he invented to confirm his views, and to establish the true theory of diffraction. Though he succeeded in making a convert of Arago, the greatest authorities then living, and the most influential men in scientific matters, both Laplace and Poisson disdained to consider the theory. The mathematical basis on which the theory rested seemed to them to be weak and insufficient. No doubt they were right; for many assumptions made by Fresnel were daring, and only justified by the results of further more careful investigations; some of his assumptions even were inaccurate. It was only when the phenomena of polarisation and double refraction were explained that Laplace acknowledged the great power of the undulatory theory, and with a remarkable inconsistency publicly stated his admiration for Fresnel's work, after a paper which is more unsatisfactory from a mathematical point of view than anything else written by Fresnel. The opposition to the undulatory theory offered by the strictly mathematical school no doubt prevented its rapid acceptance by the general body of scientific men, but it is doubtful whether its final success was delayed. On the contrary, Fresnel was spurred on to greater exertions, and the excitement caused by the violent views taken by the opposed parties rendered the question a burning one, which it was necessary to settle definitely. The impartial observers had, at the time of which we are speaking, one strong argument for suspending their judgment. One great class of phenomena, now known under the title of phenomena of polarisation, were unexplained as yet, and it seemed doubtful to them whether the undulatory theory could successfully overcome the difficulty. Then, as before, it was Young who first gave the physical explanation, while it was reserved for Fresnel again to show how the explanation was sufficient to account numerically for all the observed facts.

Those who first started the idea of luminous undulations founded their belief in great part on the analogy between the phenomena of light and those of sound. In a wave of sound each particle moves in the direction in which the waves are propagated, and it was natural to make the same supposition for the waves of light. Yet the mass of unexplained facts forced Young to consider the alternative case of waves in which the motion is in a plane at right angles to the direction of propagation. The waves of water in which such a motion partly takes place may have given to Young the first idea of a supposition which, as he showed, could account for many apparently singular phenomena. But his want of taste for calculations as well as for experimental verification prevented him from reaping the full fruits of his fertile ideas. Fresnel tells us that when he first conceived independently the idea of transverse vibrations he considered the supposition so contrary to received ideas on the nature of vibrations of elastic fluids, that he hesitated to adopt it, and he adds: "Mr. Young, more bold in his conjectures and less confiding in the views of geometers, published it before me, though he perhaps thought it after me." But when once the question was raised, Fresnel applied to it the patient skill which, either by strict mathematical deductions or by happy guesses and assumptions surmounted all difficulties. The phenomena of double refraction and their connection with polarisation were now explained, and all the varied phenomena of light seemed naturally to follow from the simple supposition of waves of transverse vibrations. Such a successful application of mathematical calculations to the investigation of physical phenomena had not been heard of since the time of Newton, and could not fail in the end to produce its due effect. The supporters of

[1] "For my part it is my pride and pleasure, so far as I am able, to supersede the necessity of experiments."—Peacock's "Life of Young," p. 477 Abstract of letter by Young.

Young and Fresnel became more numerous and confident, and the scientific societies duly acknowledged the services rendered by both. Young was elected one of the eight foreign members of the French Academy, and Fresnel received the Rumford Medal of the Royal Society, which, however, only reached him on his deathbed.

The undulatory theory now entered on a stage in which it could be taken up by the mathematician pure and simple. Its foundations had to be rendered more secure, and its consequences had to be worked out to a greater extent than even Fresnel had done.

The scruples which hindered most of the French mathematicians from accepting Fresnel's views were shared by Poisson, who deduced from his equations a result apparently paradoxical. According to Fresnel's formulæ, the centre of the shadow of a small circular disc formed by a luminous point should be as bright as if the disc were absent. But, however curious this result might be, it had been observed just 100 years before Fresnel's time, and as that experiment had been completely forgotten, Poisson's theoretical conclusion had again to be subjected to the test of experiment, when it was found to be completely in accordance with fact.

But the most remarkable discovery made solely by calculation was the so-called conical refraction, theoretically deduced from Fresnel's wave surface by Sir Wm. Hamilton. That great mathematician had found that a point, when looked at through a crystalline plate cut in a certain direction, should appear not as a point, but as a ring, and the fact was verified experimentally by Prof. Lloyd. This discovery has always been considered one of the greatest triumphs of mathematical physics, and justly ranks on equal terms with the discovery of the planet Neptune by Adams and Leverrier. It is necessary to remark, however, that strange and unexpected conclusions, especially when they have been arrived at after complicated mathematical transformations, tempt us sometimes to exaggerate the additional support which their verification gives to the theory by means of which those conclusions have been reached. It is extremely unlikely that any theory should account for all the facts explained by Fresnel, and not also for all those discovered by his successors. As a matter of fact, Fresnel's wave surface is not the only one which has been suggested, but as they all contain the singular points at which the conical refraction is produced, this phenomenon is no proof that Fresnel's equations are strictly correct. It often happens in mathematical explanations of physical phenomena that the equations originally deduced contain a series of constants which are then determined to fit the experiments. This process, which is perfectly legitimate, does however often prove only that the theory is successful in giving us a useful formula of interpolation, and need not be conclusive in favour of the ideas which have led to the formula. In a considerable number of cases, such as the reflection of light from metals, and even the theory of double refraction, we have different formulæ which all give, as far as we can test them, a sufficiently correct account of the facts, and none of them therefore prove anything in favour of the views which the different authors of the equations have put forward.

Before leaving our consideration of the services rendered by mathematics to the undulatory theory, we must not forget to notice the mathematical investigations by means of which its foundations have been placed on a safe dynamical basis. The investigations of Cauchy, those of Green, which followed, but especially those of Stokes, have secured for this theory such a firm support that even Laplace might have accepted it without further scruples. As a matter of history these investigations have done little towards the final victory of the theory. They came too late to affect the course of events, but they have increased the confidence of mathematicians in physical theories, and have prepared the way for further investigations.

As I have already remarked, it is one of the great objects of mathematical physics to investigate how far we can safely push certain assumptions and where a new hypothesis must be brought into play. And, indeed, when we have carried our calculations as far as we can, when we have experimented and measured as much as we can, we find that the undulatory theory as it stands at present, though following up to a certain point with marvellous accuracy the true course of nature, shares the common fate of all theories, and leaves a vast quantity of facts unexplained and waiting for more complete investigations. Nor is this to be wondered at; our assumptions as regards material media may in many cases give correct results and no doubt answer very well as a first approximation, but we arrive at a point where such a material medium can no longer be considered homogeneous, and here our conclusions must break down; but it is to mathematics that we must look for the next great step. The progress of the science of optics during this century has shown us how much mathematical calculation can help to establish a great and important fact such as the existence of that all-pervading medium, the vibrations of which constitute light, and I may review more quickly the recent progress of other branches of science.

In the science of heat we do not require mathematical calculations to show the superiority of the mechanical over the corpuscular theory. Sir Humphy Davy's experiment shows conclusively that heat cannot be a substance, and Joule's experiments served further to illustrate the great advantages of the mechanical theory. The mathematical treatment of thermic problems was not required to establish a theory, but was suggested by practical considerations. The important question, how much work we can get out of a steam-engine first attracted mathematicians, and out of this question the present science of thermodynamics may be said to have arisen.[1] Carnot, who gave the initial impulse to these mathematical investigations, assumed in his papers that heat was indestructible, though he seemed personally inclined to prefer the mechanical theory, which denied that indestructibility. Carnot's investigations were only gradually appreciated, and it was only when Clausius and Thomson corrected his theory so as to bring it into accordance with modern ideas, that general attention was directed to the subject. It was found that so many important consequences of physical interest (as the lowering of the freezing-point of water by pressure) followed out of Carnot's corrected reasoning that the mechanical theory now rapidly made its way, and though, as already mentioned, the proof of its truth rests on a perfectly simple experiment, mathematics must be considered to have had an important share in the final establishment of that theory.

It seems impossible to speak of the services rendered by mathematics to the progress of our knowledge of heat without mentioning the great law of the dissipation of energy. No two sciences seem further apart than mathematics and metaphysics, yet mathematical propositions have often furnished material for metaphysical speculations on the workings of nature. Thus the many dynamical propositions involving minimum or maximum properties, such as the principle of least action, have been taken to show that nature always works with the least expenditure of force, and thus the important law of dissipation of energy, which asserts that the world must have a slow and gradual end, could not fail to be used in the discussion of its sudden and abrupt beginning. These metaphysical speculations react again on the progress of physics, but it seems doubtful how far this indirect influence of mathematics has been beneficial; at any rate mathematicians cannot be held responsible for such an extension of their power.

An offshoot of the mechanical theory of heat is the molecular theory of gases. The idea on which that theory is based is not new, but it remained a speculation merely until, chiefly through the labours of Joule, the mechanical theory of heat was experimentally established, and its laws investigated. There is perhaps no branch of science in which mathematics has had such unexpected results in forming and confirming our faith in purely physical conceptions. That matter is made up of atoms and molecules is an hypothesis which simplifies many physical and chemical problems. It may, on chemical grounds especially, be considered a highly probable hypothesis, but we could hardly have obtained the confirmation amounting to proof which the idea has received of late years, without the mathematical treatment which it has received at the hands of Clerk Maxwell and those who have followed in his footsteps. One of the most astonishing results obtained by Maxwell is the one subsequently verified by experiment, that so long as Boyle's law is true, the coefficient of viscosity, as well as that of the thermal conductivity in a gas, is independent of the pressure. This fact alone, which could never have been obtained without the aid of mathematics, is a sufficiently strong foundation on which we may rest our belief in molecules. It would be extremely interesting to follow out the more recent developments of the mechanical theory of gases, and to show how both mathematics and the absence of mathematics have advanced its progress, but if it is

[1] Foucault's investigations, though of enormous mathematical importance, cannot be said to have had a direct influence on the progress of physics.

a good rule to say nothing but good of the dead, it is a better one to say nothing at all of the living.

I have already alluded to the mathematical treatment of electricity and magnetism. The aid of mathematics here was not required to confirm a theory, but rather to prepare the way for one. The complicated laws, regulating the attractions of electric and magnetic bodies, and of bodies carrying electric currents, have by the aid of mathematics been reduced to their simplest form, and electrical units have been connected with the ordinary mechanical units. This interesting branch of physics will furnish us with an example of the services which mathematics has rendered in directing the efforts of experimenters into the proper groove. We need only compare the magnetic measurements which were made during the last century with those made in our own time. While the early investigations gave us only a series of numbers impossible to interpret without a large quantity of accessory data, which are generally omitted, modern measurements, even when made by non-mathematicians, have generally been suggested by mathematical calculations and very often serve a useful purpose.

I have hardly alluded, as yet, to the science of dynamics, which is the foundation of all applications of mathematics. Its progress has been steady since the time of Galileo, but all the marvellous results arrived at by Newton and his followers, results which first showed the great fertility of applied mathematics, are too familiar to need any enumeration from me. The modern researches in hydrodynamics may perhaps not as yet have led to any definite result of physical interest, but they are rapidly progressing towards that end, and we may look forward to an increasing number of physical discoveries made by the aid of mathematics.

In tracing the history of some of our modern theories, I have followed the usual plan of presenting the history of science as illustrated by the discoveries of our great scientific men. It is necessary, however, to draw attention to the fact, and I have tried to keep this point in view throughout this discourse, that it is not always the most conclusive arguments which carry the day, and that secondhand thinkers have often had a more potent influence in shaping the course of scientific history than those to whom we now justly ascribe the greater merit of discovery. In our historical studies, therefore, we ought to direct our attention not less to that which has influenced public opinion, than to the actual soundness and originality of each discoverer.

If we ransack old books of science we often come across passages of long-forgotten writings, in which, when they are properly construed, when new meanings are given to old words and obscure expressions are freely translated, we may trace a faint prophetic glimmering of a modern theory. Such passages have a peculiar charm for the student of scientific history; they are often the only reward for much patient and otherwise useless reading, and are interesting as showing the almost boundless ingenuity both of him who made the statement and of him who interpreted its meaning. But those who are fond of this process of exhumation ought not to forget that two parties are necessary to every advance in science—the one that makes it and the one that believes in it, and the course of history is as much affected by the second class as by the first.

> "A jest's prosperity lies in the ear
> Of him that hears it, never in the tongue
> Of him that makes it."

A scientific man, in so far as he influences the progress of science, cannot be far ahead of his time, and though his writings may be read and admired centuries after his death, he will have written in vain if he has not been appreciated by his contemporaries or by those who immediately followed them. For our present purpose, then, we must consider not so much those mathematical arguments which appear now to us the most conclusive ones, but such as did appear conclusive to those whose opinion they were meant to affect. But if we try to discover what arguments have had the greatest power in removing old prejudices and in causing a solid advance in science, we find that they have often been of the most flimsy nature. Analogies, sometimes not even good ones, have succeeded where solid reasoning has failed, prejudices have been overcome only by other prejudices, and a rough illustration of a point of secondary importance may have made a previously obscure theory look more familiar, though not more clear, to the popular mind. What, for instance, has the existence of Jupiter's four satellites to do with the question whether the earth turns round the sun or the sun round the earth? Yet the discovery of these satellites has produced a greater revolution in favour of the Copernican theory than anything else that Galileo wrote on the subject.

If we look at the history of science from the point of view suggested by these considerations, we find that in addition to the legitimate influence of mathematics which we have traced, its practical effects, through less reasonable causes, have often been as powerful. The statement that in science authority is of no avail against argument, is one the proof of which must be looked for in the future, rather than in the past. There can be little doubt that authority has had a great effect in all scientific revolutions, and the authority of mathematicians was always greater than that of other men of science. Men are thoroughly convinced in one of two ways only; either by a train of reasoning which they can fully appreciate, or by one which is entirely above their comprehension. To those who are particularly amenable to the second kind of proof, mathematics has always been a magic power. Many results first obtained by the help of advanced mathematics have since been deduced by more elementary reasoning, but it seems questionable whether the original author would have been as successful in overcoming the inertia of his contemporaries, if he had confined himself to language intelligible to the greater number of his readers. It is no doubt due to this cause that mathematical papers have brought with them more widespread convincing power than we should now feel inclined to accord to them. The papers of Young, in which he avoided mathematical symbols, may appear to us sufficient to establish the undulatory theory of light; the arguments of Sir Humphry Davy, the experiments of Joule, may seem absolutely conclusive in favour of the mechanical theory of heat; but although the mathematical investigations of Fresnel, Clausius, and Thomson could be appreciated only by a much smaller number of readers, they had a more powerful influence in turning the scale of public opinion in favour of the modern ideas. It seems sometimes almost as if it required an experimentalist to convince a mathematician, and a mathematician to convince the general world. It is impossible to enter into greater detail or to exemplify more amply the assertions which I have made without touching on delicate and controversial matters, but on the present occasion it seemed to me to be specially fitting to point out that the course of science is as much affected by the appreciative faculty of receptive minds as by the creative faculty of the discoverer.

It is given to few only to take an active and successful part in the production of scientific work. The young man who begins life with the idea of making a name as a scientific discoverer is like the little girl in *Punch* who intended to become a professional beauty. They may both be successful, but if so, it will depend as much on the ready appreciation of their contemporaries as on themselves. The advance of science takes place through many channels, and each generation has its own part to play. Particular ideas, particular faculties are wanted at particular times, and no one can foretell where success will be. Men who are now quoted as shining lights would have passed away unnoticed had they lived at other times, and many a life has been one of patient but unsuccessful work, because its energies were devoted to a subject which was barren, or at least lay fallow for a time. No one, for instance, who has attempted to read through J. B. Morinus' work (and I doubt whether any one has ever got beyond the attempt) can fail to notice in him qualities which might have made a successful discoverer. In his method of determining longitudes by lunar distances Morinus has left us a lasting legacy. During the greater part of his life, however, his energies were devoted to the study and application of astrology, and all the labour spent on that subject was thrown away, although he did his best to make his own prophecies come true, and, having predicted the end of the world for a certain year, went through with his share of the proceedings, and died a natural death at the appointed time. *A priori*, there was no reason why astrology when married to mathematics should not have produced a healthy progeny, and looking especially to the state of science at the time, we can have little fault to find with the old astrologers; it is only the long and sad experience of their failure and disappointment that has given us the right to laugh at their unproductive efforts.

History then does not teach us any royal road to success. But more important for the ultimate progress of truth than a solitary success is the training of the faculty which enables the scientific man to judge correctly, and to appreciate the results of those who strike out new roads and extend the boundaries of knowledge. It seems to me to be one of the chief objects of an institution like this to bring up men, who, by conscientious consideration of scientific speculations, may help to give that solidity and elasticity to public opinion which is necessary for the rapid advance of science.

If I say that the study of applied mathematics is pre-eminently fitted for the improvement of an acute and correct judgment, I only express a sentiment which, I am sure, is felt by each of my colleagues for his own subject. Where so many attempts are made, let us hope that one may have the desired effect.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Smith's prizes were adjudged as follows:—The first to Mr. Herman, of Trinity College, the Senior Wrangler; the second to Mr. Yeo, of St. John's College, the Second Wrangler.

Mr. W. F. R. Welden, B.A., of St. John's College, has been nominated to study at the Zoological Station at Naples till June 1, 1882.

Among the subjects for which Downing College offers minor scholarships of from 40*l.* to 70*l.* per annum (examination June 6) are Chemistry, Physics, Physiology, Comparative Anatomy, and Botany. No candidate will be examined in more than three subjects, and two of them must be chosen from the first three named. Great weight will be given to special proficiency in one subject. The scholarships are open to non-collegiate students, or to those who have resided less than one term in any college. In June, also, the College offers one foundation Scholarship in Natural Science, open to all members of the University who have not kept more than six terms.

Prof. Stuart has been elected a Member of the Council of the Senate until November 7, 1884, in the place of Prof. Cayley, resigned.

The Burney prize for the present year is to be given for an essay on the following subject: "The Teleological argument for the existence of an intelligent and moral First Cause, as affected by recent Scientific Investigation."

Mr. MacAlister is lecturing at St. John's College on Methods of Physical Diagnosis for medical students beginning chemical work. Dr. Gaskell is lecturing on Respiration; Mr. Lea will lecture in March on Physiological Chemistry.

THE Chair of Agriculture at the Royal Agricultural College, Cirencester, vacant at the close of the present Session, has been offered to and accepted by Mr. Herbert J. Little, of Coldham Hall, Wisbeach.

SCIENTIFIC SERIALS

Journal of the Asiatic Society of Bengal, vol. l. part 2, No. 4 (December 21, 1881), contains: W. T. Blanford, notes on an apparently undescribed species of Varanus from Tenasserim and notes on other reptiles and amphibia.—T. Wood-Mason and L. de Nicéville, second part of rhopalocerous lepidoptera from Port Blair, Andaman Islands, with descriptions and notes on new or little-known species and varieties (plate 14). This last adds twenty-two species to the fauna.—Geoffery Nevill, description of a new species of Rostellaria from the Bay of Bengal (*R. delicatula*).—W. T. Blanford, a numerical estimate of the species of animals, chiefly land and fresh-water, hitherto recorded from British India and its dependencies: Mammals 405, Birds 1681, Reptiles 514, Batrachia about 100, Fishes 1357, Mollusca land and freshwater, about 1000, Coleoptera, 4780, Hymenoptera 850, Lepidoptera 4620, Hemiptera about 650, Neuroptera about 350, Diptera 500 (?) Orthoptera 350 (?) Arachnida 120, Myriapoda 50, Crustacea, land and fresh-water, 100. A glance at these figures and a comparison of them with the number of species known of the Arthropod orders in Europe will show Anglo-Indian naturalists how much there is yet to be done before the fauna of this great country approaches a complete enumeration.—J. Wood-Mason, on *Euripus cinnamomeus*, a new species from North-East India (plate 4).

Annalen der Physik und Chemie, No. 1, 1882.—Determination of temperature-changes in expansion and contraction of metal wires, and the mechanical equivalent of heat, by H. Haga.—Discussions on the Fourier-Poisson theory of heat-conduction, by W. Hergesell.—On the relation of the freezing-point of salt-solutions to their laws of tension, by F. Koláeck.—Remarks on Herr Wullner's note on the spectra of hydrogen and acetylene, by B. Hasselberg.—Fresnel's interference-phenomena treated theoretically and experimentally, by H. Struve.—On the application of the telephone to determining the resistance of galvanic elements and batteries, by E. Less.—On the existence of a dielectric polarisation in electrolytes, by R. Colley.—On the differential pulley, by C. Bohn.—Theory of refraction on a geometrical basis, by A. Kerber.—On the electric resistance of gases, by E. Edlund.—Remarks on Herr F. Auerbach's second paper on magnetic reaction, by G. Wiedemann.—On an apparatus for representing the phenomena of geysers, by the same.—On the Wheatstone bridge, by K. F. Slotte.

Archives des Sciences Physiques et Naturelles, January, 1882.—Experimental researches on the action of poisons on molluscs, by E. Yung.—Memoir on the new registering barometer of the Meteorological Observatory of Lausanne, by H. Dufour and H. Amstein.—The landslip at Elm, by A. Heim.—Researches on the ethers of right tartaric acid, by A. Pictet.

Zeitschrift fur wissenschaftliche Zoologie, vol. xxxvi., part 3 (December 30, 1881), contains:—Dr. G. Haller, on the structure of the Sarcoptidæ (bird parasites—Dermaleichidæ), plates 24 and 25.—W. Mau, on *Scoloplos armiger*, O.F.M., being a contribution to a knowledge of the anatomy and histology of the Annelids, plate 26 and 27.—Elias Metschnikoff, comparative anatomy studies:—(1) Entoderm formation in the Geryonidæ; (2) on some stages of the parasite of *Carmarina*, plate 28.—Dr. August Gruber, on *Dimorpha mutans*, a transition form (Mischform) between the Flagellates and Heliozoa, plate 29.—Dr. August Gruber, a contribution to a knowledge of the Amœba, plate 30.—Prof. Herbst, the natural history of the badger.—Prof. A. Bütschli, contribution to a knowledge of the skeleton of the Radiolarians, especially that of the Cyrtidæ, plate 31-33.

Rivista Scientifico-Industriale, January 15.—On radiophony, by A. Volta.—Two specimens of tourmaline and beryl from Elba (with chromolithographs), and Elban microlite, by A. Corsi.—Insects in winter, by P. Bargagli.—A means of facilitating the preparation of some insects, by P. Stefanelli.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 26.—"The Influence of Stress and Strain on the Action of Physical Forces." By Herbert Tomlinson, B.A. Communicated by Prof. W. Grylls Adams, M.A., F.R.S. Part II. Electrical Conductivity. (Abstract.)

The temporary alteration of electrical conductivity which can be produced by longitudinal traction was measured for all the metal wires used in Part I., both in the hard-drawn and annealed condition, and, in addition, for carbon and nickel.

The electrical resistances of all the substances which were examined, were, with the exception of nickel, increased by temporary longitudinal stress. With nickel, however, of which metal a wire nearly chemically pure was at length with difficulty procured (through the kindness of Messrs. Johnson, Matthey, and Co.), the resistance was found to *diminish* under longitudinal stress not carried beyond a certain point; but after this point had been attained, further stress began to increase the resistance. The effect on nickel appears still more remarkable when we reflect that the change of dimensions produced by the stress, namely, increase of length and diminution of section, would increase the resistance.

The *specific* resistances of all the substances, except nickel and aluminium, were increased by temporary longitudinal stress. With aluminium and nickel the specific resistances were *diminished* by stress not carried beyond a certain limit.

One of the most remarkable features discernible in the results is the similarity of the order of the metals to that of the order of "rotational coefficients" of metals recently given by Prof. Hall (NATURE, vol. xxiv. p. 46; abstract of a note read by Prof E. H. Hall at the meeting of the British Association at York); indeed so striking is the relationship in the case of the metals iron, zinc, aluminium, and nickel, that there would appear to be no doubt that a series of experiments made with a view of determining the effects of mechanical stress and strain on the "rotational coefficients" would be of the greatest value.

Another point to be noticed is that the alteration of the specific resistances of the alloys brass, platinum-silver, and German-silver, is much less than that of the several constituents of these alloys, and at first sight there would appear to be some relation between the alteration of resistance caused by change of temperature and that due to mechanical stress; but it has been proved by these and other experiments that the increase of resistance caused by rise of temperature is in some cases one hundred times that attending the same amount of expansion by mechanical stress; and, apart from the fact that with nickel and carbon the effects of change of temperature and of longitudinal stress are of an opposite nature, it is evident that the former are to be attributed to other causes than mere expansion.

Compression was proved to produce on the electrical resistance of carbon a contrary effect to that caused by extension; this statement applies to the alteration of specific resistance as well as of the total resistance.

Stress, applied in a direction transverse to that of the current, was also found to produce in several metals both temporary and permanent alterations of resistance of a nature opposite to those resulting from longitudinal traction.

Stress applied equally in all directions by means of an hydraulic press was proved to diminish the resistance of copper and iron; and the experiments showed that the lowering of the temperature of the freezing-point of water can be accurately and readily measured by observations of the change of electrical resistance of a wire.

The total resistance of most metals is permanently increased by permanent longitudinal extension, but with nickel the *total resistance* is permanently *decreased*, provided the extension does not exceed a certain limit: beyond this limit further extension causes the resistance to increase.

The small effects which can be produced by permanent extension, hammering, and torsion on specific electrical resistance were very fully investigated, and are shown in the paper by a series of curves. All the metals examined, except iron and nickel, have their specific resistances increased by strain caused by the above-mentioned processes, provided the strain does not exceed a certain limit, beyond this limit further strain decreases the specific resistance. In the case of iron and nickel, on the contrary, the specific resistance is at first *decreased* and afterwards increased.

The effect on the resistance of annealed steel produced by heating and suddenly cooling was also studied, and it was proved that if the steel be heated to a temperature under "dull red," sudden cooling *decreases* the resistance; whereas if the metal be heated up to or beyond "dull red," sudden cooling *increases* the resistance: the strain, therefore, caused by this process, and that resulting from purely mechanical treatment, are similar as regards their influence on the electrical resistance.

The amount of recovery of electrical conductivity produced by time in wires, which are in a state of strain, is shown in the paper for several metals by a series of curves, and these exhibit most conclusively the superiority of platinum-silver over German-silver when an accurate copy of a standard resistance has to be kept for a long period of time; in fact, of all the metals tested, German-silver showed the most marked recovery of conductivity, and platinum-silver the least.

The recovery of electrical conductivity is in all cases attended with recovery of longitudinal elasticity and of torsional rigidity.

A full examination of the influence of permanent strain on the susceptibility to temporary change of resistance from change of temperature showed that metals may be divided into two classes. In the first of these classes, which includes iron, zinc, and platinum-silver, the strained wire is *most increased in resistance* by rise of temperature up to a certain limit of strain, whilst beyond this limit further strain diminishes the first effect. In the second class, which comprises copper, silver, platinum, and German-silver, the strained wire is *least increased in resistance* by rise of temperature, but that, here again, after a certain point of strain has been reached, the first effect begins to be diminished.

After some trouble, means were found of measuring with considerable accuracy at 100° C. the alteration of electrical resistance due to temporary longitudinal traction, and the experiments led to the belief that the elasticity of iron and steel is not temporarily but *permanently* increased by raising the temperature to 100° C. Subsequently direct observations of the elasticity made in the manner described in Part I., but on shorter lengths of wire, placed in an air-chamber, the temperature of which could be maintained constantly at 100° C., proved beyond a doubt that if M. Wertheim, to whom we owe so much of our knowledge concerning elasticity, had examined the elasticity of iron and steel after these metals, tested at the higher temperature of 100° C., had again cooled down to the lower one, he would have found that what to him *appeared*, in the case of these metals (*Ann. de Chimie et de Phys.*, 3me série, 1844, p. 431) to be a *temporary* increase of elasticity was *really* a *permanent* one, and if the wires used had been tested several times, first at the higher and then at the lower temperature, he would have also found, *provided sufficient rest after cooling had been allowed*, that the elasticity of both iron and steel is *temporarily diminished* by raising the temperature to 100° C.

The temporary alteration of susceptibility to change of resistance from change of stress, which is effected in the case of nickel by raising the temperature to 100° C., is as remarkable as the susceptibility itself, and the maximum diminution of resistance which could be produced by stress when the metal was at the temperature of the room was actually *more than twice* that at 100° C.

The alteration of electrical conductivity which can be produced by magnetisation was carefully studied, and a full account of the modes of experimenting, of the apparatus employed, and the precautions adopted will be found in the paper. The substances examined were iron, steel, nickel, cobalt, bismuth, copper, and zinc, and in all cases, except that of copper, it was proved that longitudinal magnetisation increases the electrical resistance, whether the substance is in an annealed or unannealed condition.

Of all the metals examined, annealed nickel was by far the most affected by a given amount of magnetising force.

The increase of resistance produced by magnetisation can be very accurately represented by the formula $\gamma = a \cdot \alpha + b \cdot \beta$; where γ is the increase of resistance, α the magnetising force, β the induced magnetism, and a, b constants for the same substance when the same amount of current per unit of area flows through the substance.

In the paper, curves are shown exhibiting the connections between increase of resistance, magnetisation, and induced magnetism. From these curves, and from the fact of the above-mentioned formula holding good, it is assumed that the resistance will go on increasing with the magnetising force even when the latter is so great that further increase of force does not produce perceptible increase of magnetism.

The "circular" magnetisation which any magnetic substance undergoes when a current is conducted through it, seems to have very little or no appreciable effect on the electrical resistance of the substance, so that, if we compare the resistances of iron and platinum, the ratio of the two will be independent of the electromotor employed in the "bridge."

The effects of temporary stress on the alteration by magnetism of the resistance of an iron or nickel wire are of a somewhat similar nature to those caused by the stress on the magnetic inductive capacity of these metals, and the same may be said with regard to the effects of the permanent strains due to extension, torsion, &c. Longitudinal stress which may be made to diminish considerably the susceptibility to alteration of resistance from magnetisation, cannot even when carried to the extent of causing breakage, change the *nature* of the alteration.

There is apparently a close relationship between the "viscosity" of a metal and its specific electrical resistance, and it seems very probable that a full investigation of the former of these two physical properties by the method of torsional vibrations would afford valuable information respecting the latter.

Zoological Society, February 7.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. Henry Seebohm, F.Z.S., exhibited and made remarks on a series of Goldfinches (obtained at Krasnoyarsk in Central Asia) which presented every form of transition between *Carduelis major* and *Carduelis caniceps*.—The Secretary exhibited, on behalf of Mr. Peter Inchbald, F.Z.S., two curious hybrid ducks, obtained on some ornamental water near Darlington.—Mr. St. George Mivart read a paper on the classification and distribution of the *Æluroidea*. He regarded this suborder as best divisible into three families—(1) *Felidæ*, (2) *Viverridæ*, (3) *Hyænidæ*. The *Felidæ* he proposed to subdivide into but two genera, *Felis* and *Cynælurus*, the *Viverridæ* into the five subfamilies, (1) *Viverrinæ*, (2) *Galidictinæ*, (3) *Euplerinæ*, (4) *Cryptoproctinæ*, and (5) *Herpestinæ*. The *Hyænidæ* were referred to two subfamilies—(1) *Protelinæ*, (2) *Hyoninæ*. The author regarded *Cryptoprocta* as a true Viverrine animal, attaching but very little importance to dental characters save as discriminating species and genera. The *Galidictinæ* were arranged to include the genera *Galidictis*, *Galidia*, and *Hemigalidia*, the last-named genus having been instituted for the species previously known as *Galidia olivacea* and *Galidia concolor*.—Mr. W. A. Forbes read a paper on some points in the anatomy of the Indian Darter (*Plotus melanogaster*), and gave a description of the mechanism of the neck in this genus in connection with the habits of the birds.—A communication was read from Prof. P. Martin Duncan, F.R.S., containing descriptions of some recent corals collected by Mr. J. Y. Johnson at a few fathoms' depth in the sea off Funchal, Madeira.—Mr. Stuart O. Ridley read a paper on the arrangement of the Coralliidæ, and gave a review of the genera and species of this family, which contains the Red Corals. The description of a new species obtained at the Mauritius was given, as well as of an interesting, but probably not new form, said to come from Japan.

Physical Society, February 11.—Annual General Meeting.—Prof. W. Grylls Adams, in the chair.—The president read the report of the council for the past year, from which it appeared that in this, the tenth year of the Society, it was in a highly satisfactory condition, and numbered 331 members.—Sir Charles Wheatstone's papers had been published; Dr. Joule's were soon to be so; and delegates from the Society had taken part in the Electrical Congress at Paris, the Lightning Rod Committee, &c.—The treasurer, Dr. Atkinson, read the audited report of the financial state of the Society; and the following officers were after a ballot declared elected for the ensuing year:—President: Prof. R. B. Clifton, F.R.S.; Vice-president (past president): Sir W. Thomson; Vice-presidents: Prof. G. C. Foster, Prof. F. Fuller, Dr. J. Hopkinson, Lord Rayleigh; Secretaries: Prof. A.W. Reinold, Prof. W. Chandler Roberts; Treasurer: Dr. E. Atkinson; Demonstrator: Prof. F. Guthrie; other members of Council: Prof. W. G. Adams, Prof. W. E. Ayrton, Mr. Shellford Bidwell, Mr. Walter Bailey, Prof. J. A. Fleming, Mr. R. J. Lecky, Dr. Hugo Müller, Prof. Osborne Reynolds, Prof. A. W. Rücker; Honorary Member: Prof. G. Quincke.—Votes of thanks were then passed to the Lords Commissioners of the Committee of Council on Education for the use of the meeting hall, to the past-president, Sir Wm. Thomson, to the Secretaries, the Treasurer and Demonstrator, as well as to the Auditors, Mr. Shellford Bidwell, and Mr. E. Rigg. Prof. Adams then resolved the meeting into an ordinary one, and called Prof. Clifton to the chair.—Dr. C. R. Alder Wright, F.R.S., then read a paper on the relation between the electromotive force of a Daniell element and the chemical affinity involved in its action. The author has investigated the causes which lead to a fall of E.M.F. in a Daniell cell when in action. He found the amount of fall for increasing current densities and plotted it in a curve. The fall was slight when pure commercial or amalgamated zinc, or zinc coated with a film of copper was employed. Amalgamated copper plate gave more rapid rates of fall than electro-coated ones. Dilute sulphuric acid round the zinc also gave a less rapid fall than sulphate of zinc solution round it. In all cases no appreciable fall was noticed when the current did not exceed eight micro-amperes per square centimetre of plate surface. With four to six times the density a decrease of EMF from 0·5 to 1 per cent. resulted, and with currents exceeding 3000 micro-amperes in density per square centimetre of surface, the fall exceeded 10 per cent. A series of experiments were made to determine the fall due to change in the density of the solution by migration of the ions causing a stronger zinc and a weaker copper solution. These showed that with nearly saturated zinc sulphate solution (sp. gr. 1·4) and very dilute copper sulphate solution, the maximum fall in E.M.F. is developed, and is less than ·04 volts; hence the total fall in E.M.F. due to migration of the ions when moderately strong currents pass is only a fraction of the total fall. It follows that the energy due to the actions taking place in the cell, although wholly manifested in electric action expressible in volt-coulombs, when the current is very small, is not wholly so manifested when the current is stronger; the author expresses this idea by calling the energy manifested in electric action *adjuvant*, and the remainder as *non-adjuvant*. He finds that the major part of the latter energy is absorbed in actions having their seat at the surface of the copper plate, and the rest in actions at the surface of the zinc plate. It is transformed into heat according to Joule's law. As a subsidiary result, it appears that the E.M.F. of a Daniell cell, with zinc and copper sulphate solutions of equal specific gravity, a pure amalgamated zinc plate, and either a freshly deposited copper or an amalgamated copper plate, is a standard subject to less departure from the E.M.F. of other Daniell cells than the Clark's standard elements, which appear to vary one from another. On the other hand, a Clark cell keeps sensibly constant to its original value if properly set up) during a period of months or years, at a constant temperature, whereas a Daniell standard falls from its original value after a few hours or days at most.

Entomological Society, February 1.—Mr. H. T. Stainton, F.R.S., president, in the chair.—The President appointed Messrs. Pascoe and Godman and Lord Walsingham as vice-presidents. One new Member was elected.—Mr. E. A. Fitch exhibited a variety of *Strenia clathrata* from Fordingbridge; two larvæ of *Anthroceridæ* from Galway; and a new Myrmecophilous Coleopteron from India.—Mr. C. O. Waterhouse exhibited specimens of *Macromela Balyi*, Crotch, and of two species of *Pentatomidæ* from India.—Sir S. S. Saunders exhibited specimens of *Halticella osmicida*, and read some notes on *Euchalcia vetusta*, Duf.—Papers read: Mr. A. G. Butler, on a small collection of Lepidoptera from the Hawaiian Islands; Prof. Westwood, descriptions of insects infesting *Ficus sycomori* and *F. caricæ*; and Dr. D. Sharp, on the classification of the Adephaga, or carnivorous series of *Coleoptera*.

Geologists' Association, February 4.—Annual Meeting.—The following were elected Officers and General Committee for the ensuing year:—President, W. H. Hudleston, F.G.S., F.C.S.; Vice-Presidents: Prof. T. Rupert Jones, F.R.S., Henry Woodward, F.R.S., Jas. Parker, F.G.S., J. Hopkinson, F.G.S.; Treasurer, J. Logan Lobley, F.G.S.; Secretary, J. Foulerton, M.D., F.G.S.; Editor, Rev. J. F. Blake, F.G.S.; Librarian, Ed. Litchfield; Wm. Carruthers, F.R.S., E. Swain, F.G.S., R. W. Cheadle, F.G.S., J. Bradford, W. J. Spratling, F.G.S., J. Drew, F.G.S., W. Fawcett, B.Sc., F. W. Rudler, F.G.S., H. Hicks, F.G.S., H. M. Klaassen, F.G.S., Prof. John Morris, F.G.S., B. B. Woodward, F.G.S.

Victoria (Philosophical) Institute, February 20.—A paper on evolution as held by Hæckel and his followers was read by Mr. Hassell. The author considered that one of the great defects of Hæckel's theory was, that it required one to believe in great effects resulting from causes which all that we knew of natural history showed must be insufficient.

Institution of Civil Engineers, February 14.—Sir Frederick Bramwell, F.R.S., vice-president, in the chair.—the paper read was on air-refrigerating machinery and its applications, by Mr. J. J. Coleman.

EDINBURGH

Royal Society, January 30.—Emeritus Professor Balfour, vice-president, in the chair.—At the request of the Council, the Rev. Dr. Cazenove gave an address on the historical (documentary) evidence for the destruction of Herculaneum and Pompeii by the eruption of Vesuvius, A.D. 79. The references to the catastrophe by contemporaneous authors, such as Martial, Plutarch, Statius, Josephus, the younger Pliny, &c., are so vague and general that they might very reasonably have been discredited if the buried cities had not been actually discovered; and it is first from a work of Dion Casius, published 140 years after the event, that we learn the names of the overwhelmed cities or get any detailed information at all. The inquiry indeed dealt a serious blow to the view held by a certain school, that historical evidence should be based only on contemporary-written records; for in this case it was the non-contemporary writer that gave the precise information.—Prof. Turner described and exhibited certain bones of a Sowerby's whale (*Mesophodon Sowerbyi*) which had been captured in Shetland in May, 1881. From a comparison with the specimen of this very rare species belonging to the Industrial Museum, he concluded that the recently-captured animal was the older, being especially characterised by the presence of a bone running down the centre of the peculiarly elongated snout, and thus filling up what, in the Museum specimen, is a well-marked groove. Probably the ossification had not proceeded far enough in the less mature animal to insure its persistence in the skeleton. The Shetland specimen (a male) also possessed two large teeth on the lower jaw, which, though present in the other, were not large enough to come above the gum. This seemed to indicate a sexual difference.—Prof. Dickson read a paper by Dr. Joseph Bancroft, on respiration in the roots of certain shore plants. His observations referred chiefly to the remarkable rootlets of *Avicennia*. These rootlets grow vertically upwards from the larger roots which extend themselves horizontally in the mud of salt-water creeks. The mud bank around the stem is covered by a brush of such rootlets to a distance of from four to six yards from the bole of the tree. This brush, by entangling *débris*, protects the bank from destruction by stream or tide. The rootlets are studded with pits or pores emitting powdery matter which consists of cells, and which may be observed floating on the surface of the brackish water of the creek. These pores he regards as corresponding to lenticels, and he finds that when air is forced into the cut end of a rootlet it issues by the pores. Hence he conjectures that the function of the pores is to contribute to the aëration of the plant, a view coinciding with that held by several botanists as to the lenticels, which they regard as structures affording, like stomata, a communication between the atmosphere and the interior of the plant.—Prof. B. Balfour presented three Latin diagnoses prepared by Dr. J. Müller, Dr. G. Dickie, and Dr. C. M. Cooke, of the lichens, algæ, and fungi collected by him and partly by Dr. Schweinfurth in the Island of Socotra.—Prof. Tait communicated a note by Prof. Piazzi Smyth, who, with the aid of a very superior spectroscope, has recently discovered that the low-temperature spectrum of oxygen does not consist of five *unique* lines as hitherto believed, but that four at least of these are triple or quadruple, and have the fluted appearance common to other low-temperature gaseous spectra.

PARIS

Academy of Sciences, February 13.—M. Jamin in the chair.—The deaths of M. Bussey, free Academician, and M. Decaisne, member in Rural Economy, were commented upon. Discourses at the funeral of the latter, by MM. Bouley, Fremy, van Tieghem, and Deschartre.—On the law of deviation of Foucault's pendulum, by M. Bertrand.—On some applications of the theory of elliptic functions, by M. Hermite.—On a new memoir of M. Hirn, "Experimental researches on the relation between the resistance of air and its temperature, by M. Faye. This memoir (noticed in NATURE, vol. xxv. p. 325) M. Faye regards as an important and pregnant scientific event.—On double salts formed by haloid salts of mercury, by M. Berthelot.—Effects of hypnotism on some animals, by M. H. Milne-Edwards. Fowls, &c., hypnotised several times by M. Harting were injured in the nervous system; they were paralysed and died. M. Milne-Edwards thinks the increased aptness of persons often hypnotised, as subjects for demonstration, is a bad sign, and that hysteric persons should not be often so treated.—Proofs of the breaking up of a southern continent during the modern age of the earth, by M. Blanchard. New Zealand and small adjacent islands (Auckland, Maquarie, Chatham, Antipodes, Bounty, and probably others) he regards as the *débris* of this old continent; finding evidence chiefly in the similarity of living things, and also in soundings and in the disappearance of the huge Moas (which he thinks explained by changes in the land, the birds having then been huddled together in small space, and perishing by hundreds). M. Alph. Milne-Edwards passed some strictures on M. Blanchard's conclusions, holding, *inter alia*, that the Antarctic islands (such as Auckland and Campbell Islands) were not formerly connected to New Zealand. M. Blanchard replied.—On the roots of sanitary matrices, by Prof. Sylvester.—Researches on the nitrogen-acids derived from acetones, by M. Chancel.—On the various nervous states produced by hypnotisation in hysteric persons, by M. Charcot. He distinguishes the cataleptic, the lethargic, and the somnambulic state.—On a spouting thermal water obtained in the plain of Forez, by M. Laur. Boring to a depth of 502 m. they observed at irregular intervals eruptions of carbonic gas projecting a column of hot water 26 m. for 20 minutes. The vertical tube had a diameter of about 8 inches. Changes of water level accompany the phenomenon.—On the employment of bitumen of Judæa against diseases of the vine, by M. Alric. He quotes information from an account of the journey of Nassiri-Khosan in Syria and Palestine. It is said that phylloxera in Palestine, in the Middle Ages, was suppressed by means of this bitumen. M. Dumas promised an analysis of the substance, a small barrel of which had been sent to the Academy.—Observations of planets 221 Palisa and 222 Palisa at Paris Observatory, by M. Bigourdan.—On the companion of the star γ of Andromeda, and on a new mode of regulation of an equatorial, by M. André. A 6-inch equatorial lately set up by MM. Brunner in Lyons Observatory decomposes clearly (with a magnification of 200) the star named, an effect generally regarded as a test for 8-inch objectives, and which seems only to have been once had before, with aid of a With silvered mirror. In regulation MM. Brumer use a spirit level and a nadir ocular.—On the distribution, in the plane of roots, of an algebraic equation whose first member satisfies a linear differential equation of the second order, by M. Laguerre.—On singular points of differential equations, by M. Poincaré.—On the forms of integrals of certain linear differential equations, by M. Picard.—On a case of reduction of Θ functions of two variables to θ functions of one variable, by M. Appell.—On quadratic forms with two series of variables, by M. Le Paige.—On the divisibility of certain quotients by powers of a certain factorial, by M. André,—On shock of elastic bodies, by M. Pilleux. He describes some instructive experiments with ivory cubes hung in a row, and an ivory ball allowed to impinge on them.—Electric actions in similar conducting systems, by M. Deprez.—On the electric transport of force to great distances, by M. Deprez. With small modified Gramme machines weighing about 100 kg. he has got a useful work of 37 kgm. with an interposed resistance of 786 ohms, representing 78·6 km. of ordinary telegraph wire.—On methods of comparison of induction coefficients, by M. Brillouin.—On the generality of the electrochemical method for figuration of equipotential lines, by M. Guébhard.—Hydrodynamic experiments; imitation, with liquid currents, of the phenomena of electromagnetism, by M. Decharme. He uses, instead of the pulsating or vibrating bodies of Bjerknes (in water), liquid currents, continuous or interrupted, acting in air or water. He describes a hydro-electromagnet with interrupted currents.—Polarimeter with ordinary light, by M. Laurent. He introduces into an ordinary polarimeter, between the tube and the analyser, a Soleil compensator, with prismatic quartz plates.—On oxychlorides of magnesium, by M. André.—On oxychlorides of sulphur, by M. Ogier.—Action of cyanide of potassium on trichloracetate of potassium, by M. Bourgoin.—On the heat of formation of ferricyanhydric acid, by M. Joannis. He arrives at the number +280·5 cal.—On galactine, by M. Muntz. This is a gum which he extracts from grain of lucerne; it is marked by high dextrogyrous rotatory power, and the property of giving, with dilute acids, the products of decomposition of milk-sugar. Leguminous grains, especially, contain large quantities of it.—On aconitrates, by M. Guinochet.—On hieratite, a new mineralogical species, by M. Cossa. This is named from *Hiera*, the Greek for Vulcano Island (Lipari), where the substance is found near the fumaroles of the crater. The composition agrees with that of fluosilicate of potassium, a salt not previously found among natural products.—Atlantic actinia from dredges of *Le Travailleur*, by M. Marion.—On fossil Echinida of the island of Cuba, by M. Cotteau.—On asterophyllites, by M. Renault.—On the nature of spheroliths forming an integral part of eruptive rocks, by M. Lévy.—On the discovery of marine carboniferous formation in Upper Alsace, by M. Bleicher.—On the anomalies of the atmospheric pressure in January and February, 1882, by M. Renou. The sky was overcast continuously for fifteen days (January 11 to 26); the bright days were warm, the dull days cold (contrary to what usually occurs in winter). From January 9 to February 7 no rain fell. The Marne and Seine were very low and extraordinary clear.

VIENNA

Imperial Institute of Geology, January 24.—Dr. Tirus, on the Scoglio of Brusnick in Dalmatia.—A. Rzehak, on oncophora, a new genus of Bivalvæ.—Th. Fuchs, on the pelagic fauna and flora.—C. M. Paul, on the region of Sanok; and Lupkow, in Gallicia.—M. Vacek, on the geology of the Nousberg.

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