THURSDAY, JULY 12, 1883

HYDRAULIC MANUAL

Hydraulic Manual. By L. D'A. Jackson. 4th Edition. Pp. xiv. + 307 Text + 184 Tables. (London : Crosby Lockwood and Co., 1883.)

THIS well-known text-book having reached its fourth edition, it is unnecessary to review it as a new work. The changes from the third edition are very great; the chief is the omission of the whole of the "Hydraulic and Meteorological Statistics" (about 224 pp. of tables); these relate chiefly to India, so that their omission is an advantage to the "Manual" as a general text-book, as it has enabled the text to be increased from 221 to 307 pp., and the general working tables from 104 to 184 pp., without increasing the bulk of the volume; the chief increase of the text is the introduction of an account of the great Roorkee hydraulic experiments.

Much stress is rightly laid on the small value of the old hydraulic knowledge; thus (p. 3) it is said, "Taken generally the mass of hydraulic science . . . prior to about 1856 may be considered superannuated. . . ." The most useful feature of this work is indeed its freedom from what is "superannuated," and its thorough adoption of recent experiment; the text is in fact in great part a short account of the great modern experiments. In detailing field operations the author has indeed preferred to give a "brief account of the modes adopted by various hydraulicians" as being "a far better guide to the engineer about to undertake the execution of gauging operations than any arbitrary advice or set of rules could possibly be." These concise accounts are on the whole well condensed; but the recapitulation—in some cases verbatim—of the several experimenters' own conclusions has the disadvantage that in several cases contradictory conclusions appear on different pages; this is inseparable from the progressive state of our knowledge of the motion of water when stated in this way; a little more discussion of the contradictory views would have been useful.

Kutter's general formula for mean velocity was early adopted by the author; its use as the formula to be preferred to all others for the case of canals (whenever velocity-observation has to be dispensed with) is now insisted on, much evidence in favour of it having been brought out by the recent large Roorkee experiments, with the very fair reservation however that Kutter's rugosity-coefficient (n) should at present be determined by actual experiment for each new channel, the data for its *a priori* determination (from the mere nature of the channel) not being as yet good enough. On the other hand it is rightly said that "to determine with accuracy the discharge of any ordinary or large river independent of velocity-observation is at present impossible."

A few minor details are worth notice. The units of measure, &c., adopted are an extremely simple and useful decimal system; they include the foot, the "foot-weight" of 1000 fluid ounces, *i.e.* the weight of a cubic foot of water at its greatest density, and a "league" of two London miles of 5000 feet each; this league is particularly suited to measurement of hydraulic slopes, a fall of 1, 2, &c., feet per league being at once seen to give a slope of 1, 2, &c., in 10,000. Two new very expressive names are introduced for two velocities, which recur very frequently in discussions on flow of water, viz. "verticalic velocity" and "transversalic velocity" for velocities past any vertical line or any (horizontal) transverse line in a channel section; these short terms will be a great relief from the wearisome periphrases hitherto in use, and merit general adoption.

A few suggestions towards improvement of the work may now be made. (1) In a purely professional work such expressions as "international recrimination," and "bureaucratic and heated with vanity" (p. 37) are surely out of place. (2) About one page of text and three of tables are devoted to the variation of gravity in different latitudes and at different heights; now the variation is so small that for the rough calculations of practical hydraulics this is an unnecessary refinement. (3) Among the "general notation" (p. 11) occurs the rather awkward phrase "g = velocity acquired by gravity in one second." (4) In finding the (trapezoidal) "section of maximum discharge" from the expression for discharge $Q = A V$ where $V = 100 c \sqrt{R S}$ and $R = A \div P$, the argument used is that "under the condition of maximum discharge, A will be a maximum, so also will R; and when these are temporarily constant, P will be a minimum;" this argument might be considerably improved, somewhat as follows:—"Since $Q = 100 c A \sqrt{R} . \sqrt{S}$, therefore Q is greatest (provided S be kept constant) when c, A, and R are all maxima together; now c is known (from experiment) to increase with R, and $R = A \div P$; hence Q will be greatest when A is a max. and P a min. at same time (provided of course that S is constant)": this argument is more general than that in the text; the effect of the S-variation is unknown. (5) About certain formulæ for "mean verticalic velocity," quoted from the Roorkee work, it is said (p. 209)—"The defect in these methods is evident; it consists in making the parabolic curvature dependent on one point or on two points, whereas three points are the least necessary." This last statement is a mistake; three points are necessary (for finding a mean ordinate) only if they be taken at random, but *two points are sufficient when suitably chosen*, as in the "two-velocity formulæ" quoted on pp. 87, 208 from the Roorkee work; these formulæ are in fact accurate for the parabolic form, and the proof of this (from the Roorkee work) is actually given at p. 87. The "one-velocity formulæ" are of course only approximate. It may be mentioned here that the writer has lately[1] discovered another (and far better) "two-velocity formula," also accurate for the parabola, viz. $U = \frac{1}{2} (v_{\cdot 211\, H} + v_{\cdot 789\, H})$, showing that the "mean verticalic velocity" is the arithmetic mean of the velocities at ·211 and ·789 (or say $\frac{2}{10}$ and $\frac{8}{10}$) of the depth: this new formula has several great practical advantages over any other yet published; among others, the two velocities can be measured at one operation with a single instrument (a compound "double-float" with two equal subfloats at the depths named), which is itself moreover susceptible of being made a more accurate instrument than any other of its class (double-float).

ALLAN CUNNINGHAM

[1] See *Proc. Inst. Civil Engineers*, vol. lxxi. pp. 18, 19, where the formula and instrument are both discussed.

ORIGINES CELTICÆ

Origines Celticæ (a Fragment), and other Contributions to the History of Britain. By Edwin Guest. Two Vols. (London: Macmillan and Co., 1883.)

A MAN'S foes are indeed those of his own household. More than one literary or scientific reputation has been injured by the injudicious zeal of a writer's friends to publish after his death the fragments and papers he has left behind. It is natural to imagine that the work and suggestions of a scholar must all be equally valuable, and that by omitting to print any portion of it the world may be a loser. But it must be remembered on the other side that a good deal which a scientific worker commits to manuscript is never intended to see the light, and that in any case it is unfair to him to publish fragmentary remains which he has never had the chance of revising and correcting.

Dr. Guest's name is deservedly one of power among all those who have interested themselves in the earlier history of our country. His papers on the Invasion of Britain by Julius Cæsar, on the Campaign of Aulus Plautius, on the Four Roman Ways, and on the Saxon Conquests in Britain, are all models of sound scholarship and careful method. Dr. Freeman acknowledges him as a master, and declares that "whenever they meet on the same ground, he ranks above Palgrave and Kemble." Friends and public alike, therefore, might have expected to find in the fragments of his unfinished work, "Origines Celticæ," a fresh monument to his historical sagacity and another contribution of importance to the ethnology of our islands.

But friends and public alike must be grievously disappointed by what is actually placed before them. It would have been far better to spare the paper and ink that has been expended upon it, and, what is of more consequence, the fair fame of the author himself. The "Origines Celticæ," which occupy the whole of the first volume and the opening pages of the second volume of Dr. Guest's posthumous works are a barren waste of unscientific theorising and uncritical collection of facts. The work carries us back to an age when the application of the scientific method to history was unknown, when ethnology and comparative philology were as yet undreamt of, and when the most amazing generalisations were built on the chance coincidence of proper names. In our search for the fathers of the Kelts we are transported to the Caucasus, to Egypt, and even to Ur of the Chaldees, and no shadow of doubt is allowed to cross the mind that Kimmerians and Kimbrians and Kymry are all one and the same people. The fact that there were Iberians in Georgia and Iberians in Spain is considered quite sufficient to prove that the early population of the Spanish Peninsula came from the sources of the Euphrates.

Dr. Guest's philology is as wild as his ethnology. He has heard of "Grimm's Laws"; but as their existence is inconvenient to his own etymological mode of procedure he denounces both the "laws" and their observers, though without understanding what they really mean. When Indo-European philology is treated in this way it is not surprising that the Rutennu of the Egyptian inscriptions are connected with the Assyrians of Resen, that initial *k* and *h* are said to interchange in Phœnician, or that an Egyptian settlement in Kolkhis is declared to admit of "no reasonable doubt."

Dr. Guest's turn of mind, in fact, was literary rather than scientific. Wherever the question was a purely literary one, he displayed erudition, patience, and common sense; where, on the contrary, it was ethnological or philological, he showed himself as helpless as a Jewish rabbi. The old well-threshed statements of Greek and Latin writers are heaped together, and tricked out here and there with references to the discoveries of Egyptian and Assyrian research. How little he knew of the latter, however, may be judged from the frequent mistakes he makes when appealing to them, as when, for instance, he insists on calling Sumer Sommari, or tells us that Assurbani-pal lived in the ninth century B.C.

Had the "Origines Celticæ" appeared a hundred years ago they would have been hailed as a profoundly learned and interesting book. There is no place for them in an age when the departments of knowledge with which they deal have been occupied by the method and spirit of inductive science. To know what Dr. Guest really was and of what he was really capable we must turn to the papers reprinted in the second volume of his remains, though even here we shall from time to time be reminded of the literary spirit which accepts what is not disproved rather than of the scientific spirit which doubts everything and holds fast only to that which is proved.

A. H. SAYCE

OUR BOOK SHELF

Handbook of Vertebrate Dissection. Part II. "How to Dissect a Bird." By H. Newell Martin, D.Sc., M.D., M.A., and William A. Moale, M.D. (New York: Macmillan and Co., 1883.)

SOME months ago we noticed in these columns (vol. xxvii. p. 335) the first of a series of Handbooks of Vertebrate Dissection, by Drs. Martin and Moale—"How to Dissect a Chelonian." The second, "How to Dissect a Bird," has now appeared, and, as the type selected is the pigeon, this volume will doubtless be appreciated by a large number of students.

The general arrangement of the book is much the same as that of its predecessor, directions being given how to proceed step by step, so that the student, with its aid, ought to be able to gain a good knowledge of the anatomical characters of a bird. The skeleton, in particular, is described in great detail, and there are four good figures and a diagram of the skull, as well as a figure of the hind limb. It is, however, to be regretted that there are no illustrations of the soft parts, for figures of the skeleton—at any rate of allied forms—can be got in almost any text-book on Comparative Anatomy, while satisfactory drawings of the viscera, &c., are not so easily obtainable.

The directions are on the whole excellent, with one or two slight exceptions. The description of the air-sacs, for instance, is very indefinite, and gives no idea of their true relations. If the authors had glanced through Prof. Huxley's recent paper on the subject in the *Proceedings of the Zoological Society*, and compared the air-sacs of the pigeon with the description there given, there is no doubt that the position of these structures and their relations to the lungs would have been stated more clearly.

We must also call attention to the following points, which are not very accurate:—

Only one pancreatic duct is described instead of three.

The inferior mesenteric artery, instead of the median sacral, is stated to be the termination of the aorta.

The descriptions of the thymus and thyroid glands appear to have been transposed.

The three divisions of the cloaca are not described, and the rudimentary right oviduct is not mentioned, though the "*Fallopian tubes*" are said to open into the cloaca.

It is a mistake to introduce questionable homologies into a book of this kind, especially when they are unsupported by fact. Thus the statement in § 118 that the "thin sheet of muscle which is closely adapted to the concave ventral surface of the lungs . . . represents the diaphragm of mammals," is certainly misleading. In the first place, the position and relations of these muscles are entirely different from those of the mammalian diaphragm, and, moreover, they receive their nerve-supply from the intercostals, the phrenic being absent. The fact that the phrenic arises so far forwards appears to indicate an entirely different origin for these two structures.

With these slight exceptions, however, the descriptions and directions leave little to be desired for clearness and accuracy. It is certain that accurate detailed directions are far more valuable for elementary teaching than more general ones; the student, once having mastered them, finds little difficulty in grasping the wider bearings of the subject. Such works as the present, therefore, which entail a careful examination of every point mentioned, not only save both student and demonstrator much trouble, but insure more accuracy in work. A series of pamphlets such as the authors intend to publish, treating of all the more important vertebrate types usually dissected in an ordinary course on comparative anatomy, will certainly prove most valuable.

An Easy Introduction to Chemistry. Edited by the Rev. Arthur Rigg, M.A., and Walter T. Goolden, M.A. New Edition Revised, pp. 148. (London: Rivingtons, 1883.)

THIS book is based on a "First Book of Chemistry," by Dr. Worthington Hooker, and is intended, we are told in the preface, "to convey information in respect to changes which are likely to attract the attention of young persons who observe and inquire."

It is questionable whether "young persons" do well in attempting to study chemistry; the chemical laboratory is not a place in every way suited to the requirements of youth, but without steady work in a laboratory no real progress in chemistry can be looked for. Should, however, any youth desire information regarding material changes which he observes around him, he will find a considerable amount of information in this little book; but should he be desirous to study chemistry, he will not we are afraid derive much assistance from this "Easy Introduction." Many experiments are described and numerous well-executed illustrations are given, but several of these experiments could not be performed by a beginner without the aid of a teacher or of much more detailed description than is given in the text. To read statements of the results of experiments is not the way by which young persons can acquire interest in or a knowledge of chemistry.

Although excellent in many ways, yet we cannot think this book will prove an efficient introduction to chemistry; a perusal of it may, however, serve to stimulate young persons to seek for an introduction to the science, some of the materials for the construction of which are put before them in this work.

Practical Electric Lighting. By A. Bromley Holmes, Assoc. Inst. C.E. Sixty-two Illustrations. (London: E. and F. N. Spon, 1883.)

IT is with pleasure that we shall watch the success of Mr. Holmes's little book on "Practical Electric Lighting." Mr. Holmes has clearly and simply put before the unelectrical public as much and no more of theoretical electricity as is necessary for his purpose, together with a good general summary of the chief machines and appliances in present use.

Besides this, much useful information is given in the last two chapters, first, on the present economic state of electric lighting, and second, on the best means of applying the power to electric machinery. If there be one point in the book not so strong as the rest it is that the descriptions of the dynamos and lamps would have been better if they had entered a little more into detail.

C. C. S.

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 insure the appearance even of communications containing interesting and novel facts.*]

Geology of the Congo

I HAVE received from one of the Baptist missionaries in the front of the Congo mission a basket of specimens of rocks and a letter giving some particulars of the geological structure of the localities. The letter may be interesting as the first news of this kind from the centre of Africa, on its western side, and I therefore place it at your service. S. R. PATTISON

5, Lyndhurst Road, Hampstead, N.W., July 7

Liverpool Station, B.M.S., Stanley Pool, Congo River, S.W. Central Africa, March 15, 1883

S. R. PATTISON, Esq.

DEAR SIR,—Before leaving England in 1879 you made us a kind offer to render us any help in geological and mineralogical matters that lay in your power, and that kindness has been recalled to mind every time I have examined a piece of rock. I had seen such geological variety in the few parts of England that I had visited, that in my ignorance I was expecting to find a much greater variety out here and at least some fossil treasures. But in this, as you may guess, I have been disappointed.

In sending home some curios the other day, I inclosed a few native ingots of lead and copper, which I thought might interest you. They are "mined" in a district of the Bizunseke tribe called Noama, some twenty-five miles west-north-west of the Ntombo Mataka Falls of the river. I have not visited the place, but I believe de Brazza (concerning whom there have been some paragraphs in the newspapers lately) passed through this "mining district."

Although I believe that no metal from that part is ever sold to white traders, it is an important item in native trade with the far interior. Some are used to make bullets, others are recast to make anklets, &c. If the district is rich, or there is much silver in the lead, the French will perhaps work there.

The case of curios was sent away before I had intended. I had hoped to have added other things, and a piece of sandstone from the cataracts here.

Mr. Stanley indirectly hinted that Stanley Pool might be the crater of a volcano (extinct of course) which in old time had rent a rift in the hills, forming an exit to the pent-up waters of a vast interior sea. I am not sure how much of this was made public by him. It was, however, his opinion on our return from our first visit to the Pool. He speaks also of lava reefs, granite, gneiss, trap, &c.

Dr. Pechuël Lösche, late of the German Expedition, which spent some time (about five or six years ago) on the coast about the Kioilo and Chiloango Rivers, was for a short time in charge of the Belgian expedition here during Mr Stanley's absence. He assures me that there is no trace of igneous action above Isangila at least. There may be traces of such action at the Yelala Falls, which form the first bar to navigation from the sea. Between there and Isangila Falls quartz, slate, micaceous, and granitic (apparently) rocks are the rule.

Above Isangila limestone is abundant for about ten miles, above that slaty rocks are prevalent. Limestone crops out again about the country of the Basundi. This gives place to a red shale at the western boundary of the Babwende, and at the Ntombo Mataka Falls a red sandstone appears under the shale.

This sandstone is soft and is broken up and rounded into huge boulders, which are covered with a smooth, chocolate-coloured, ferruginous glaze, deposited by the river, and hardened by the sun. These boulders thus glazed might well have been regarded by Mr. Stanley as trap and lava, &c., while the large grain of the stone, together with the appearance of the blocks in some places might suggest its being granite. This sandstone with the exception of a little which is quartzitic, is the only rock I have seen between Manyanga and Stanley Pool, and is certainly the rock at the great Ntamo cataracts here.

On the hills and cliffs about the Pool there are some white shining patches, which I hear are sand, but I believe there is no calcareous rock in the neighbourhood. The pool itself is a strange break in the lines of sandstone hills, which, although now much eroded by water, are the remains, doubtless, of what was once a plateau, at the level of about 1500–1800 feet above the sea.

On the road to San Salvador from our old Musuka station we find boulders of ironstone and small nodules of the same, mixed with clay, on the top of quartz, micaceous, and granitic rocks. Limestone crops up in several places, but the principal formation visible is the ironstone clay. In all this country I have not met with a trace of a fossil of any kind.

When at Landana, about two miles south of the mouth of the Chiloango River, some months ago, I saw some stones from the cliffs which appeared to be almost identical with a Portland stone (?) which I have seen used in fortifications in the south of England. There were many fossils, but I could neither spare time to examine the cliffs nor carry many specimens, being on an express journey by hammock up the coast. This was the only occasion that I have met with any fossils in Africa, and that in a part of the coast now well known through the work of the German Expedition. The quartz, micaceous, slate, shale, and sandstone rocks of this part of the continent are a poor field for palæontologic research.

I am very curious as to the geological formation of the Congo Valley between this point and the Stanley Falls, but at present have learned nothing. I should expect, however, to find the sandstone the only visible rock.

I wish that I could speak with better acquaintance with the names of the rocks, but often I feel sorely puzzled. On our first journey to Stanley Pool we mistook some strangely shaped hills near to Manyanga for granite, but have since ascertained them to be singular relics of the sandstone.

I need not enter into details of our work, which are so fully and constantly reported in the *Missionary Herald*. Regretting that the information I can supply is so meagre,

Believe me, dear Sir, yours very truly,

W. Holman Bentley

Intelligence in Animals

1. I observe that Dr. Romanes, in his very interesting work on "Animal Intelligence," has been good enough to notice an account given by me in Nature, vol. xi. p. 29, of an instance of a scorpion committing suicide under special excitement. It may be well to remention the fact that in this case the rays of the sun, focused on the back of the scorpion by means of a common lens, were the exciting cause of the self-inflicted fatal sting; and to set the matter at rest it may be remarked that two witnesses who saw the experiment can corroborate my statements. On reconsidering the whole affair, however, it occurred to me that in wounding its own back the scorpion may have merely been trying to get rid of an imaginary enemy. The concentrated rays of the sun no doubt caused pain, and the sting was probably directed towards the seat of this in an automatic manner, as a defensive act. This seems to me a more feasible explanation than to regard the action as due to an instinct detrimental to the individual and to the species.

2. While writing on the subject of "animal intelligence," it has occurred to me that the following remarkable example is worthy of being put on record:—Some years ago, while living in Western Mysore I occupied a house surrounded by several acres of fine pasture land. The superior grass in this preserve was a great temptation to the village cattle, and whenever the gates were open, trespass was common. My servants did their best to drive off the intruders, but one day they came to me rather troubled, stating that a *Brahminy bull* which they had beaten had fallen down dead. It may be remarked that these bulls are sacred and privileged animals, being allowed to roam at large and eat whatever they may fancy in the open shops of the bazaar-men.

On hearing that the trespasser was dead, I immediately went to view the body, and there sure enough it was lying exactly as if life were extinct. Being rather vexed about the occurrence, in case of getting into trouble with the natives, I did not stay to make any minute examination, but at once returned to the house with the view of reporting the affair to the district authorities. I had only been gone a short time, when a man, with joy in his face, came running to tell me that the bull was on his legs again and quietly grazing! Suffice it to say that the brute had acquired the trick of feigning death, which practically rendered its expulsion impossible, when it found itself in a desirable situation which it did not wish to quit. The ruse was practised frequently, with the object of enjoying my excellent grass, and although for a time amusing, it at length became tiresome, and resolving to get rid of him the sooner, I one day, when he had fallen down, sent to the kitchen for a supply of hot cinders, which we placed on his rump. At first he did not seem to mind this much, but as the application waxed hot, he gradually raised his head, took a steady look at the site of the cinders, and finally getting on his legs, went off at a racing pace, and cleared the fence like a deer. This was the last occasion on which we were favoured with a visit from our friend.

G. Bidie

Ootacamund, June 5

The Mealy Odorous Spot in Lepidoptera

The mealy spot on the base of the front margin of diurnal Lepidoptera, which emits an odour supposed to serve for sexual purposes, is present only in the male. It is therefore most interesting to observe that this spot is not always present in different individuals of the same species. Among the numerous varieties of *Papilio priamus* proved by rearing to belong to that species, the spot in question is present only in *P. priamus*, and is wanting in the male of all the varieties which have come under my observation. *Callidryas eubule* has the spot present only in specimens from Florida; it is wanting in all specimens from other localities of the United States, including a large number from Texas. In *Colias electra* and *edusa*, Keferstein (*Wien. Zool. Bot. Gesell.* 1882, p. 451) states that after an examination of a series of males he has found the mealy spot only exceptionally present, and the same is supposed by him to be the case in other species of *Colias*.

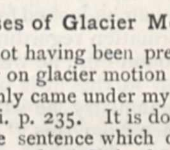
It would be interesting to know how this exceptional presence of so prominent a characteristic is to be explained.

Cambridge, Mass., June 21 H. A. Hagen

Causes of Glacier Motion

Unfortunately not having been present when Mr. W. R. Browne read his paper on glacier motion at the Royal Society on June 15, 1882, it only came under my notice when published in Nature, vol. xxviii. p. 235. It is doubtless of little importance, but there is one sentence which does not seem to read exactly as I wrote it, namely, "It (a glacier) will get a series of cracks *in its longer axis*," should be "*across* (or transverse to) its longer axis," which I think makes the meaning more clear.

I may perhaps mention that when ice on lakes becomes from four to seven feet thick the effect of a sudden decrease of temperature does not, for obvious reasons, always cause a complete solution of continuity of the ice all the way through from its upper to its under surface, the crack being wedge-shaped, thus—



so that the water sometimes does not flow into the crack; the equable and higher temperature of the water counteracting at a certain point of the ice's thickness the penetration and consequent contracting influence of the colder air.

When the ice has acquired the great thickness above mentioned, the cracks by contraction are never so wide as when the ice is from one to three feet thick, but as far as I can remember they were more numerous, and when the water did not flow into them, were drifted full of snow by the first breeze of wind.

4, Addison Gardens, July 7 John Rae

Sand

Not having had the pleasure of perusing Mr. Waller's paper on sand, I gather from Mr. Gardner's notice of it that it is an attempt to distinguish by the aid of the microscope whether sand has been formed by the action of wind or of surf. Having a number of years ago become possessed with the idea that the form of the materials which make up the soils and subsoils found in any country might lead to a knowledge of the sources from which they had been derived, I had many soils and subsoils from Europe and Australasia looked at, but without being able to detect sufficient difference of shape or form as to lead to any definite result. Having been long familiar with the soils formed out of the boulder clay and drift of the south-east of Scotland, I had hoped to have seen a very marked difference in the form of the particles of sand existing in them from those of the interior of Victoria, New South Wales, and Queensland, large portions of the surface coverings of which countries are believed to have been deposited when covered with the sea. This difference exists certainly—that the soils of the boulder clays and drifts contain a far greater portion of fine and rough gravel, and rounder in shape than do those from Australia. Yet, so far as I could observe, the form of the sand was similar. It seems to me that both Messrs. Waller and Gardner are on the wrong track when searching solely for the typical forms of sand in the seashore or from torrents. The amount of sand found on the seashores of the world is large, no doubt, so is that from the rivers. What is that to the quantities contained in the surface coverings of the land? It is from this source the rivers obtain the supply they carry to sea or the shores, and make up the waste by friction. It has long seemed to me probable the sands, fine gravels, and silt formed by the passing of ice over the surface of the rocks would have a distinct form from the surface covering produced by other forces. The gravel or shingle of the rivers has a flatter shape than that of the seabeach when derived from the same rock. If such difference can be discovered in the silts, sands, and gravels derived from glacial action, it may be possible to assign limits to the extent to which ice has effected the present covering of the surface from the broken up strata over which it has passed. Silt, sand, and shingle must all, however, be taken into account, and that from the deposits themselves, not from what has been subjected to littoral, fluviatile, or wind action.

Bonnington JAMES MELVIN

Garfish—Wild Fowl

With reference to Mr. Archer's note in NATURE last week (p. 226), may I remark that the beak of the garfish of southern waters (*Hemiramphus*, A.) is of rather too fragile a nature to be capable of making a slit of four inches in length in a hard felt hat? May not the fish in question have been more likely a young and small *Xiphias*—or, as is equally probable, a juvenile *Pristis* or sawfish—emulating with the thoughtless exuberance of youth the habits of *Exocetus*?

Any Australian can confirm the correctness of Dr. Rae's observations in the same page of NATURE *re* wild ducks and railways. Looking down upon the reedy waterholes on the south bank of the Yarra, from Princes Bridge in Melbourne, abundance of native waterfowl can any day be seen swimming about in conscious security and much less on the alert than they are in any swamp in the loneliest part of the bush. The constant roar of a great passing traffic, as well as the unceasing turmoil and unearthly noises of a large railway station within stone's throw of their haunts, is now quite unnoticed by these usually most watchful and wary of all birds.

But for the fear of trespassing on your space, I could give many more illustrations of the truth of Dr. Rae's remarks and of the quick and unerring instinct which so soon teaches both furred and feathered animals to dread less the roaring and shrieking ogre that is so swiftly tearing his way into their most secluded haunts in the uttermost parts of the earth than the silent, solitary biped who with gun in hand creeps stealthily upon them. ROBERT S. GOODSIR

Edinburgh, July 9

Glowworms

While watching, last evening, some glowworms in a mossy stone wall, my attention was attracted to a firefly flying to and fro in the field beyond and approaching the wall where I stood. Arriving within two or three feet of the glowworm I was watching, he made several sharp zigzag flights, drawing nearer the light of the glowworm, and then, making a dash like that of a hawk at an object it has been watching, pitched directly on the glowworm, covering it in the fraction of a second. I had been noting the curious habit of this, which thus appeared to be the female insect, of standing with its abdomen erected in the air and quite motionless, except for a sort of pulsation, but on the contact of the male, the body fell to a normal position, and it was evident that coïtus was taking place. I watched them ten minutes until I was completely satisfied that this was the case, when I swept them both into a card box which I send with this for examination by a competent entomologist of the insects, which have not the slightest likeness to each other, the female resembling in general form the glowworm of England, but having an intenser light, and the light-emitting organs, beside the abdominal, which is the most luminous as well as the largest, being two glands (apparently) situated where the joints of wings might be expected if the insect were winged. The light is of an exquisite green, and so brilliant as to pale little at the proximity of a wax taper burning at six inches' distance.

This morning, on opening the box, I found the female apparently dead and collapsed; but the male, on the light returning to them, attempted to renew his embraces.

I remember a discussion at Cambridge (U.S.A.) some years ago, in which Agassiz conjectured that the light of the glowworm served as an amorous guide, but I had only a few weeks before noticed quite a different use for it. In one of the primitive forests of New York State, where twilight is normal from the density of the shade, I was attracted by the loud buzzing of a fly under a recumbent tree trunk. On looking for the cause of it I found a large, luminiferous insect resembling in general construction the common glowworm, but with powerful mandibles, which had built itself a little pit resembling that of an ant-lion, at the bottom of which it was lying, its light distinctly visible. The fly was in the clutch of the mandibles, helpless, though as large as a bluebottle, nor could I easily extricate him. There could be no more mistaking in his case that the light was a decoy than in this of the Pistoiese insect being a sexual invitation.

W. J. STILLMAN

Cutigliano, Pistoiese Apennines, June 25

[The name of the glowworm is *Lamprorhiza splendidula*, a common South European species.—ED.]

Mimicry

I heard what I fancy was rather a curious instance of mimicry last Wednesday evening (June 28) about 10 o'clock. I was walking with a friend across a field adjoining a meadow, in which was a landrail (*Rallus Crex*); we both noticed that the animal's cry, or crake as it is called here, was pitched in a higher and somewhat softer key than is usually the case, and my friend remarked that perhaps it was a young bird, but we were considerably surprised to hear him imitate the cry of the lapwing (*Tringa vanellus*). At first this cry was uttered only once alternately with several crakes, but we listened for about ten minutes, at which time, I suppose, he fancied that his note was perfected (which, however, it was not, being much less sharp than the pee-wit of the lapwing), and so he essayed it several times in succession. But he ultimately relapsed into his craking again.

Filston Hall, Shoreham, Kent, July 4 A. HALE

Indian Numeration

In your review (p. 195) of "Field and Garden Crops of the North-Western Provinces and Oudh" you speak of the peculiar system of numeration used by the author, as in the instance 6,79,06,496, expressing sixty-seven millions, &c. Perhaps I may be allowed to point out that this marking is quite in accordance with the native Indian method of numeration, in which there is no word equivalent to "million." In India the series runs thus:—Thousands, tens of thousands, lakhs, tens of lakhs, krors (or crores). A lakh is a hundred thousand, a kror is ten millions.

It may be doubted whether it is advisable to adopt this system in an English book, for even native readers of it would easily enough follow our own; still it is not uncommon to see lakhs and krors made use of in English official papers.

Of three questions asked by the reviewer, the above remarks give an answer to one; as to the others I may say that a "seer" is two pounds avoirdupois, and a "maund" is forty seers.

Eton College, July 4 FREDERIC DREW

FUNERAL OF MR. SPOTTISWOODE

THE funeral of the late President of the Royal Society on Thursday last was impressive and solemn, and was a fitting end to the life that had passed away.

We take from the *Times* the following account of the general arrangements of the funeral:—

A large number of those who were present assembled in the Jerusalem Chamber, which the Dean had kindly placed at the disposal of the family. Those who by courtesy were styled pall-bearers met here—Dr. Evans, Vice-President and Treasurer of the Royal Society, the Marquis of Salisbury (Chancellor of the University of Oxford), Earl Granville (Chancellor of the University of London), Mr. Childers, Sir W. Siemens, the Duke of Northumberland, Sir Frederick Leighton, P.R.A., the Master of the Stationers' Company, Lord Aberdare, Sir John Lubbock, Mr. E. J. Stone, Sir Bartle Frere, Prof. Flower, Sir W. Armstrong, and, representing departments in the firms with which the name of Spottiswoode is connected, Mr. Shinn, Mr. Millwood, Mr. Carey, Mr. White, Mr. Howe, Mr. Wilson, Mr. Hamilton, and Mr. Straker. Others, who went first to the Jerusalem Chamber, were the Archbishop of York, the Bishop of Lincoln, Mr. Mundella, M.P., Mr. Shaw-Lefevre, M.P., the Dean of Christ Church, the Master of Balliol (Prof. Jowett), the Archdeacon of Maidstone, Sir Frederick Bramwell, Sir Richard Cross, M.P., Mr. Warren De La Rue, Sir Frederick Evans, Sir Joseph Fayrer, Sir James Caird, Lord Claud Hamilton, the Hon. George Brodrick (Warden of Merton), Mr. W. H. Smith, M.P., Mr. W. E. Forster, M.P., Sir Charles Dilke, General Sir H. Rawlinson, Sir James Paget, Mr. Irving, Prof. Huxley, Sir Joseph Hooker, Mr. Lecky, Sir Richard Temple, and Mr. J. Norman Lockyer. Some again, among whom were Lord O'Hagan, Sir Walter Stirling, Sir Henry Barkly, Sir James Cockle, the Dean of Wells, Mr. Philip Magnus, Director of the City and Guilds of London Institute, Mr. Trueman Wood, Secretary, and Mr. Wheatley, Assistant Secretary of the Society of Arts, Mr. Symons, F.R.S., of the Meteorological Society, and Sir John Kennaway, M.P., at once took their places in the choir or south transept, the seats in the north transept being reserved for *employés* of Messrs. Eyre and Spottiswoode and Messrs. Spottiswoode and Co.

Besides those who have already been named, the list of mourners invited to attend in the Jerusalem Chamber included the following gentlemen, of whom nearly all were present:—

Mr. Andrew Cockerell (representing his Royal Highness the Prince of Wales), the Lord Mayor, Mr. Gladstone, the American Minister, Count D'Aunay, Count Munster, the Lord Chancellor, the Earl of Northbrook, the Duke of Argyll, the Duke of Buccleuch, the Earl of Derby, the Earl of Ducie, the Earl of Dufferin, Earl Sydney, Sir Stafford Northcote, M.P., Lord Sherbrooke, Earl Spencer, Sir Frederick Abel, C.B., Capt. Abney, R.E., Prof. Acland, M.D., Prof. J. Adams, LL.D., Prof. W. Adams, M.A., Sir George Airy, K.C.B., Prof. Allman, M.D., Prof. C. Babington, M.A., Mr. John Ball, M.A., Mr. P. W. Barlow, F.G.S., the Earl of Rosse, Lord Chelmsford, Lord Eustace Cecil, Lord Lawrence, Lord Reay, the Marquis of Hartington, M.P., Lord Rayleigh, Lord Colin Campbell, Lord Carlingford, the Earl of Kimberley, Earl Amherst, Lord Houghton, the Bishop of London, the Dean of St. Paul's, the Bishop of Truro, the Dean of Salisbury, Mr. W. J. Farrar, Mr. W. H. Barlow, Mr. J. F. Bateman, F.G.S., Prof. Beale, M.D., Mr. I. L. Bell, F.C.S., Sir J. R. Bennett, M.D., Mr. George Bentham, F.L.S., Mr. Beresford-Hope, M.P., Sir Henry Bessemer, Mr. H. W. Blake, M.A., General Boileau, F.R.A.S., the Rev. T. G. Bonney, M.A., Mr. W. Bowman, LL.D., Mr. T. L. Brunton, M.D., Mr. G. B. Buckton, F.G.S., Sir C. J. Bunbury, Lord Cardwell, F.G.S., Dr. W. B. Carpenter, C.B., Mr. W. Carruthers, V.P.L.S., Prof. Cayley, V.P.R.A.S., Mr. Chamberlain, General Clark, R.A., Prof. R. B. Clifton, M.A., the Earl of Crawford and Balcarres, Prof. W. Crookes, F.C.S., Mr. T. B. Curling, F.R.C.S., Prof. G. H. Darwin, M.A., Prof. W. B. Dawkins, M.A., Prof. H. Debas, Ph.D., Prof. J. Dewar, M.A., Prof. Duncan, M.B., Mr. Edwin Dukin, F.R.A.S., Mr. W. T. Dyer, M.A., Sir W. Elliott, K.C.S.I., Mr. A. J. Ellis, B.A., Mr. Arthur Farre, M.D., Mr. Fawcett, M.P., Mr. James Fergusson, D.C.L., Prof. G. C. Foster, B.A., Dr. M. Foster, Prof. E. Frankland, D.C.L., Capt. Douglas Galton, C.B., Mr. Francis Galton, M.A., Dr. J. H. Gladstone, Mr. J. Glaisher, F.R.A.S., Mr. R. Godwin Austen, F.G.S., the Right Hon. J. G. Goschen, M.P., Lieut.-Col. J. Grant, C.B., the Right Hon. Sir W. H. Gregory, K.C.M.G., Sir W. Grove, Sir W. Gull, Mr. Albert Gunther, M.A., Prof. F. Guthrie, F.G.S., Mr. W. A. Guy, M.B., Sir W. V. Harcourt, M.P., Mr. A. G. Harcourt, V.P.C.S., Sir John Hawkshaw, Mr. Thomas Hawksley, M.I.C.E., Mr. R. B. Haywood, M.A., Mr. P. G. Hewett, F.R.C.S., Mr. James Heywood, F.G.S., Dr. T. A. Hirst, Prof. A. W. Hoffman, Ph.D., Mr. J. Hopkinson, M.A., Dr. W. Huggins, Mr. J. W. Hulke, F.R.C.S., Prof. Humphrey, M.D., Dr. J. H. Jackson, Dr. J. G. Jeffreys, Sir W. Jenner, K.C.B., Dr. J. C. Joule, Sir John and Lady Kennaway, Admiral Sir Astley Cooper Key, K.C.B., Prof. Ray Lankester, M.A., General Sir J. H. Lefroy, C.B., Mr. Joseph Lister, F.R.C.S., Admiral Sir F. L. M'Clintock, Sir H. Sumner Maine, LL.D., Prof. Marshall, V.P.R.C.S., Prof. N. S. Maskelyne, M.A., Mr. C. W. Merrifield, Mr. Alfred Newton, M.A., Prof. Odling, Mr. Daniel Oliver, F.L.S., Prof. Owen, C.B., Dr. John Percy, Mr. W. H. Perkin, C.S., Major-Gen. Pitt-Rivers, Sir Lyon Playfair, M.P., Dr. W. Pole, Mr. W. H. Preece, C.E., Prof. J. Prestwich, M.A., the Rev. Bartholomew Price, the Rev. Charles Pritchard, M.A., Dr. Quain, Sir A. C. Ramsay, LL.D., Prof. Osborne Reynolds, Admiral Sir G. H. Richards, C.B., Mr. G. J. Romanes, M.A., Prof. H. Roscoe, B.A., Mr. Osbert Salvin, M.A., Prof. Sanderson, Mr. P. L. Sclater, M.A., Mr. R. H. Scott, M.A., Mr. John Simon, C.B., Mr. W. W. Smyth, M.A., General W. J. Smythe, Mr. H. C. Sorby, LL.D., Mr. H. T. Stainton, F.L.S., Prof. Balfour Stewart, M.A., Prof. G. G. Stokes, M.A., General R. Strachey, R.E., Prof. J. J. Sylvester, M.A., Dr. Allen Thomson, Sir W. Thomson, LL.D., Mr. J. Todhunter, M.A., Prof. Tyndall, Dr. A. W. Williamson, Mr. W. H. Pollock, Mr. E. Bunbury, the Rev. B. Compton, Mr. Horace Davey, Q.C., M.P., the Head Master of Rugby, the Provost of Eton, the Head Master of Eton, the Hon. Ralph Dutton, the Hon. Robert Butler, Mr. Osborne Morgan, M.P., the Bishop of Exeter, Sir Louis Pelly, Sir Henry Thompson, Sir James Lacaita, Mr. J. Boehm, Mr. A. Milman, Mr. W. Hasseltine, Mr. F. Pollock, Mr. Pascoe Grenfell, Mr. T. Woolner, Mr. Lawrence T. Cave, Mr. T. H. Gordon, the Rev. W. H. Milman, Mr. T. Chenery, Mr. W. F. Burton, Mr. Douglas Freshfield, General Hutt, Dr. W. Grey, Dr. Priestly, Prof. Bryce, M.P., Mr. W. C. Cartwright, Sir Julian Goldsmid, Sir Louis Malet, Sir Rutherford Alcock, Sir Arthur Hobhouse, Sir Charles Mills, M.P., General Sir M. M'Murdo, General Sir Patrick Grant, Sir Charles Trevelyan, Sir James Stephen, Sir Charles Bowen, Lord G. Hamilton, M.P., the Recorder of London, Alderman Sir S. H. Waterlow, M.P., the Wardens of the Stationers' Company, Col. Donnelly, Prof. Ruskin, Cardinal Manning, a deputation from the Chemical Society, Mr. J. G. Dodson, M.P., Dr. Cumberbatch, Dr. Gibbons, Mr. Robert Browning, Mr. E. Chinnery, Mr. J. A. Froude, Sir R. Lingen, Mr. Herbert Spencer, the Dean of Llandaff, Sir Harry Verney, M.P., Lord Wolseley, Mr. Cyril Graham, Mr. Charles Eastlake, Mr. George Frere, F.R.S., Mr. Talfourd Ely, Sir Thomas Pears, Prof. Leone Levi, Prof. Max Müller, Mr. Frederick Verney, Mr. H. C. Hughes, and Major Gordon.

The body was borne from the house in Grosvenor Place to the Abbey on an open funeral car drawn by four horses. In the carriages immediately following the funeral car were Mrs. Spottiswoode, Mr. Hugh Spottiswoode, Mr. G. A. Spottiswoode, Mr. Cyril Spottiswoode, Mr. Rate, Mrs. George Spottiswoode, Miss Spottiswoode, Miss Augusta Spottiswoode, Mr. Arthur Brandreth, Mrs. Brandreth (sister of Mr. Spottiswoode), Mr. and Mrs. G. Noble Taylor, Mr. T. P. Beckwith, Miss Ellen Arbuthnot, Miss Mabel Spottiswoode, Mr. Adrian Spottiswoode, Mr. Norton Longman, Miss Longman, Miss Elizabeth Spottiswoode, Mr. Eyre, Mr. and Mrs. R. M. Bray, Mr. Frederick Arbuthnot, Miss Margaret and Master John Arbuthnot, Mrs. Beckwith, Mr. Sydney Beckwith, Mrs.

Jervoise, and Mr. Rate, jun. The servants came next in two carriages, and after the empty family carriage, the carriage of his Royal Highness the Prince of Wales, and then those of friends of the family.

At the entrance to the cloisters a company of the 2nd London Rifle Volunteer Regiment, formed of *employés* of the Spottiswoode establishments, stood with arms reversed as the procession passed through to the Abbey. At the West Cloister door, choristers, scholars, and clergy, the Rev. Flood Jones, precentor, the Rev. John Troutbeck, Minor Canon, Canon Rowsell, Canon Barry, Archdeacon Farrar, and the Dean, met the body. Immediately behind the chief mourners, and in front of those from the Jerusalem Chamber came, by special invitation of the family, Earl Stanhope, the Earl of Dalhousie, Sir F. W. Pollock, and Mr. J. F. Moulton; then Mr. Andrew Cockerell, representing the Prince of Wales, and among those from the Jerusalem Chamber, Mr. George Busk, Vice-President of the Royal Institution. The coffin, still covered with its lovely floral tributes, was placed under the lantern, while the 90th Psalm was sung to Purcell's Burial Chant, and the lesson was read by Canon Duckworth. As the notes of the anthem died away the body was borne to its last resting-place, near the grave of Archbishop Spottiswood. So great was the congregation of mourners, that not half the number could find standing room in the narrow aisle in which the grave is made. The Dean said the "Committal" and the prayers, and after the singing of Bishop Wordsworth's well-known hymn, "Hark, the sound of holy voices, chanting at the crystal sea," the Dean pronounced the blessing, and the mourners, casting into the grave the wreaths and bunches of flowers which many of them had carried, slowly dispersed. Dr. Bridge played the "Dead March" in "Saul" at the conclusion of the funeral service. The inscription on the plate of the coffin, which for sole decoration bore a Latin cross of brass, was—

WILLIAM SPOTTISWOODE,
Born January 11, 1825,
Died June 27, 1883.

A sermon *in memoriam* was preached in the Abbey by the Dean on Sunday afternoon.

THE ECLIPSE PARTY

LETTERS have been received from the English and American members of the above, giving some details which we think may prove of interest to our readers.

Leaving England on February 17 in the s.s. *Medway* the English observers made a calm passage to Colon. Here they met the American party, consisting of Prof. Holden, Dr. Hastings, Mr. Rockwell, Mr. Preston, Lieut. Brown, and Mr. Upton, to which it will be remembered they were to be attached. The united party then proceeded to Panama, and took ship in the *Bolivia* for Callao, where they arrived on March 20. Early the following morning the instruments and baggage were removed to the U.S.S. *Hartford*, in which the voyage from thence was to be made, and the party left Callao about five o'clock on the evening of March 22, sighting Caroline Island, the spot selected for the observations, on April 20. Although named Caroline Island it is not a single island, but a low-lying chain of coral islets which enclose a central lagoon. The ring of islets is about seven and a half miles in length, and one and a half in breadth The island like most of its kind is of value on account of its stores of guano, and its cocoanut produce, being leased to Messrs. Houlder Brothers of 146, Leadenhall Street, whose agent at intervals visits this, and other Pacific coral islands leased to the firm. On the arrival of the *Hartford* a boat under the charge of Lieut. Qualtrough put off to make a tour of inspection, returning with the intelligence that there were two large empty frame houses, several smaller ones, and seven inhabitants—four men, one woman, and two children—who had come thither from Tahiti two months previously. A site having been selected by Prof. Holden for the erection of the observatory, the work of disembarkation commenced. This was a matter of great difficulty, the nature of the coast preventing even the small ship's boats approaching within several hundred yards of the shore. The boats had first to run in through a narrow opening in the reef, the boxes had then to be carried through fifty yards or so of water, varying in depth from two to three feet, next over about fifty yards of sharp irregular coral rock that cut the men's shoes to pieces, and finally to be carried up a soft sandy beach for upwards of a quarter of a mile. However, the landing was effected without accident, and the observers took possession of their various quarters.

The English observers report that the house in which they were located was a very comfortable one, containing a kitchen, dining-room, bed-room, bath-room, and store-room, and a large laboratory. Mr. Rockwell, one of the American observers, was fortunate enough to obtain the luxury of a bed. Mr. Upton, another of the party, had to be content with a table, whilst the rest swung their hammocks and cots in the verandah, an arrangement which, while possessing perhaps advantages of its own when the weather was fine, was not altogether the best when the nights were wet. Still the observers were not uncomfortable; and if they did not "fare sumptuously every day," yet, with abundance of fish and cocoanuts, they did not live altogether badly.

The weather, with the exception of one severe rainstorm, was pleasant during the sojourn of the observers, although nearly every day slight showers were brought to the island by flying clouds.

On the evening of the 22nd, just as the *Hartford* was casting off for Tahiti, *L'Éclaireur* came in with the French expedition, consisting of MM. Janssen, Trouvelot, Palisa, and Tacchini on board.

The preparations for the eclipse proceeded briskly, and by April 28 the siderostat, equatorial, and photoheliograph were erected and adjusted in position. The spectroscopes were next taken in hand, and the rating of the clocks proceeded with. This took some time; but matters had so far advanced by May 1 that from that date, with the exception of May 4, when the weather was wet, two rehearsals of the observations were made daily, one at 7, the other at 11.30 a.m. Messrs. Preston and Brown of the U.S. Coast and Geodetic Survey during this period made pendulum observations.

By the evening of May 3 the photographers were nearly ready to take trial plates, and these they hoped to obtain the following day. The hitherto fine weather, however changed, and before noon the next day five inches of rain had fallen, and the photographic dark room which had been erected was destroyed, all the dye being washed out of the ruby curtains and window. This damage being repaired, an attempt was made to obtain trial plates the next day, but the length of time occupied in rehearsing the observations, and the still unsettled state of the weather, prevented this being done. The early morning of the eclipse found the weather in the same unsettled state; about nine o'clock, however, the clouds began to disperse themselves, and by ten o'clock the sky was moderately clear. After the first contact the lenses were dusted, the slits of the spectroscopes cleaned, and the adjustments finally inspected.

With regard to the work of observation itself, this was done in accordance with the programme laid down before the observers left England, although the time-table of exposures was slightly departed from to meet the circumstances of the case, as, for instance, a greater length of totality than was expected, the duration being five minutes twenty-five seconds. During the eclipse the direction and velocity of the wind remained constant.

whilst the meteorological observations of Mr. Upton showed a slight rise in barometric pressure, a rise in humidity, and a fall of temperature, the latter reaching even the nightly values, whilst radiation thermometers showed that the heat received by the earth was almost *nil*.

The observations with the photoheliographs which the English observers took out being taken in hand by Lieut. Qualtrough of the American navy.

Perhaps some details as to the work itself may be of interest.

First with regard to the work of Mr. Woods. A red-end collodion plate was washed and placed by him in one of the prismatic camera slides five minutes before totality. Four minutes later he started the clockwork of the integrating spectroscopic slide. Forty seconds before totality exposures were made in the Rowland grating cameras, and at totality the prismatic camera and slit spectroscope were each opened.

In the spectroscopes which were under the care of Mr. Lawrence the exposures commenced ten minutes before totality, his work continuing until ten minutes after totality.

The photoheliographs as we have said were looked after by Lieut. Qualtrough, the plates which he exposed in these instruments being given to Mr. Woods after the eclipse. During the intervals in the exposures of the plates the observers found time to note the corona. In its general character it seems to have much resembled that seen last year in Egypt, but its light was of a more natural tone, the landscape lacking the weird colouring so marked a feature in the Egyptian eclipse

Mr. Lawrence examining the corona with the finder was able to detect much delicate detail, especially in those portions of it near the preceding limb of the moon. He also examined it with a small pocket spectroscope with lens. Taking out the prisms during mid totality he could see the green ring, and very faintly towards the end C and D_3. After totality he still saw the 1474 ring, as well as the red and yellow ones; these latter, however, being as before very faint. Replacing the prisms he could see then only the 1474 line, that examined by Prof. Hastings. The F line, for which he had specially searched, was not seen by him at all. Mr. Lawrence agrees in thinking that the coronal light was of a more natural tint than it was in the eclipse last year. Mr. Dixon of the American party made a careful sketch of the corona, showing five well defined streamers. Soon after totality the photoheliograph clock was stopped, and an endeavour made to obtain the run of the sun's crescent on the two cameras for the purpose of orientation, but, owing to the prevalence of clouds, the attempt was only successful with one, the smaller instrument, with which two exposures were obtained on one plate.

So much for the observations themselves. As to the results we learn that the photographs taken with the small photoheliograph are very good, that which had two minutes exposure showing as much as those which M. Janssen exposed during the whole of totality. The large photoheliograph has not given such good results, all the plates taken showing signs of slight shifts. Still it is believed that, by combining the photographs on each of the nine plates, the whole structure of the corona from the limb to its outmost limits will be obtained.

With the first order grating H and K were obtained as bright lines just before, and immediately after, totality, but with the second order grating no result seems to have been obtained; at least the observers could see nothing when they examined the plate on the island. The photographs taken with the dense prism spectroscope, like those obtained with the first order grating, show bright lines at the commencement and end of totality, particularly at the end, the photograph taken then showing H, K, *h*, *f*, and F very distinctly.

The integrating spectroscope also did useful work. Although no result was obtained during totality with this instrument, the flash of bright lines before and again after totality were successfully photographed by it. The more prominent lines in these photographs are those which belong to hydrogen and the lines H, K, and 1474.

The slit spectroscope was also successful, giving a good photograph from the ultra violet to the green. This spectrum, whilst being in the main a continuous one, is not the same on the two sides of the disk, nor are the lines so numerous as those obtained last year in Egypt. H and K are very strong in the present photograph, but in this respect also the spectrum differs from that obtained in Egypt, these lines then extending across the interval, which is not so in the present photograph. The hydrogen line near G, however, extends over nearly a solar diameter; and *h*, F, 1474, *b*, and other lines have also been obtained.

With regard to the gelatine red-end plates of the prismatic camera, although they gave good photographs, yet the almost entire absence of prominences will diminish their value. In the eclipse of last year, when many prominences were visible, these plates were used with good results. The Rowland grating, too, seems to have given no useful result, but this is probably due, like the small measure of success with the prismatic camera, to the comparative absence of prominences.

In developing the red-end plate immediately after totality Mr. Woods was unfortunate enough, owing to his having to manipulate it almost entirely in the dark, to get it torn, and nothing now remains but the gelatine edging.

The work now being complete, the things began to be repacked for the homeward journey. The *Hartford* returned to Caroline on the 8th, the work of reembarkation commenced, and on the 9th the expedition left.

The observers were almost sorry to leave the island, as their sojourn there had been a most pleasant one. Like most of its kind it is well wooded, the graceful outlines of the cocoanut palms being characteristic features in the pretty scenery which the island affords.

By day the smaller hermit crab swarmed the sandy beach, feeding on what decayed animal matter it could find, whilst at night the large red hermit crabs covered the same beach in their hundreds, they preferring dead vegetable matter. The lagoon too, around which the little islets arrange themselves, was a never-failing source of interest and amusement, and in boating there, and in the deeper water off the reef, or in hunting the shore in search of the brilliant-coloured shells and coral with which the island abounds, the observers found much amusement.

In deep water bivalve shells more than two feet across were observed, whilst the reefs at low water were covered with smaller representatives of the same or a similar species, which threw jets of water into the air. Several octopi were caught by the various members of the expedition, and many beautiful sea-urchins picked up by them in their daily walks. Thus did they spend their spare hours, and it was therefore with some regret that they saw the outlines of the island disappear on their horizon. The *Hartford* was bound for Honolulu in the Sandwich Islands. The voyage was however broken at Hilo, Hawaii, in order that the members of the expedition might visit the celebrated volcano of Kilauea. Honolulu was reached on May 30. Here Messrs. Preston and Brown, who were to continue their pendulum observations remained, the rest of the expedition proceeding in the *Zealandia* for San Francisco. The English observers left at Honolulu copies of the photographs they obtained, to be forwarded to England by the next mail. They left San Francisco on June 15, and may therefore be expected to arrive in England about the end of the present month.

THE ARCHÆOLOGY OF SOUTHERN CALIFORNIA[1]

A VALUABLE contribution to American anthropology has recently appeared, published under the auspices of the U.S. Government, forming the seventh volume of the "Reports of the U.S. Geographical Surveys West of the One Hundredth Meridian." It deals mainly with the remains of the Indians of Southern California, their implements, weapons, vessels, and ornaments.

The observers and collectors were those engaged upon the work of the survey, some of them detailed for work of a different character, but fortunately able to render valuable assistance in explorations for archæological finds.

The letterpress embodies the work of F. W. Putnam, the distinguished curator of the Peabody Museum, whose editorial revision and direction has moulded the whole, that of A. A. Abbott, the veteran explorer of the antiquities of New Jersey, H. C. Yarrow, S. S. Haldeman, A. S. Gatschet, H. W. Henshaw, and Lucien Carr, whose report upon the measurements of the crania from California is most suggestive and important. Besides their own contributions to the principal subject, these gentlemen have freely used the short descriptions of the personal visits of the officers of the army and others to the Pueblo villages of New Mexico and Arizona.

The present inhabitants of Central and Southern California are regarded as a degenerate race deteriorated from an ancestral people of superior parts, and they afford to-day a marked contrast with the more advanced and intelligent races of Northern California. This inferiority has been recognised by all observers, and was comprehended by the Jesuit missionaries, whose unfortunate system, however much its zealous propagation recommended their vigour and sincerity, only helped the natural tendency and hastened the course of a degradation already under way.

As early as 1534 the Spanish explorers invaded this region, and met in many instances a warlike and determined resistance. The priest and missal followed the sword and helmet, and completed the destruction of the people by processes more insidious than those of the warrior, but scarcely less fatal. Missions were established, the natives proselytised, not always by moral suasion, and brought under the control of the missions; they existed in a state of appanage, and became listless and degraded.

The natives of the immediate southern border of California show an improvement over those of Central California, approximating to the superior type in Northern California, a contrast which has so impressed the minds of students as to have started the assumption that the Central Californians belong to a different race, and are to be referred to Malay and Chinese origins. It is however with the description of the implements, utensils, ornaments, &c., of the southern Indians as exhumed from burial mounds, and the story told by such mortuary relics of the habits of their ancestors, that this volume is filled.

Attention had been directed by the Smithsonian Institution to the area upon the coast of California opposite the group of Santa Barbara Islands, and to these islands themselves, as a promising field for archæological search. The indications followed rewarded the Survey with many important objects, enough to permit a conception of the life of their makers.

These latter were in the stone age depending upon stone and bone implements as tools of war, chase, and industry. They seem to have been almost entirely without a knowledge of pottery, but this need may have been scarcely felt from their skill in the manufacture of stone vessels formed from steatite masses, and of all sizes, and adapted to the commonest domestic uses.

This series of objects affords a striking example of their patience and ingenuity. They are described under the designation of "Cooking pots and food vessels." They are in the main oblate spheroidal vessels of soapstone thickened over the base and sides exposed to the heat, and thinning towards the rim of the circular opening upon the top. The smaller specimens are frequently much finished in their smoothness, and vary enough in size and shape to suggest that they were the property of individuals, and prepared and kept for the personal use of their owners. These small vessels often show mending where fractured, a row of holes being perforated upon the two opposite sides of a crack, and the edges drawn together by sinews which are sunk in grooves, over which has been plastered asphaltum. Asphaltum figures in various ways, and was constantly resorted to as a convenient cement; it was employed to fasten their stone-bolts and arrow-heads to their shafts, to attach mouth-pieces to their pipes, the line to their fish-hooks, &c., it formed a surface over their objects upon which ornaments could be imbedded in rude decoration, and figures on their shell beads in spiral lines of black.

Besides the *ollas*, various dish-like utensils are figured with one or more holes for suspension after use, or for removal from the fire, being probably used as baking pans. Stone mortars of basalt and sandstone, small colour mixers, dishes of shell (*Haliotis*), and cups formed of fish vertebræ complete the list of serviceable vessels.

The smoking-pipes, which are carefully studied and described by Dr. Abbott, are long, straight, conical, and sub-cylindrical tubes of steatite, displaying no great variety of form and but inconspicuous attempts at ornamentation. The straight tube corresponding to the bowl of the common pipe is in line with the opening at the insertion of the mouthpiece, and it would seem that tubes of bone or reed inserted for stems must have been curved to permit of their use in any normal position.

The chipped flints are of striking beauty, and will be recognised by all who have examined specimens of ornamental spears and daggers from this region. They are shown of natural size upon two plates of considerable beauty, and vary from 4 inches to 8 or 10 inches in length, lenticular in section, and present ripple-like and corrugated surfaces of very delicate sculpture. The chapters upon perforated stones, miscellaneous objects made of stone, and textile fabrics are especially interesting.

The claim of any great age for these relics seems precluded by their association with glass beads, bronze cups and platters, iron swords, nails, knives, and pistol barrels, all pointing unmistakably to contact with the Spaniards. Yet there can be but little doubt that they perfectly represent the arts of life prevailing among the ancestors of their owners and makers for ages before the appearance of the white man, and that many are themselves heirlooms descended from a great antiquity.

The concluding chapter of Part I. is a suggestive summary of the results of cranial measurements, and the writer, Lucien Carr, indicates the past presence of two races whose intermingling remains are now found upon the Santa Barbara Islands, one—the dolichocephals or long heads—presenting a picture of subjugation and decadence; the other—the brachycephals or short heads—spread over the mainland, occupying the northern islands, and pressing upon the precarious remnant of their predecessors on the southern islands.

Part II. is a diversified compilation of a number of personal narratives of visits to the Pueblo villages, some chapters upon the implements and pottery of their occupants, which seem of a degraded type compared with the productions of their probable ancestors, and a short

[1] "Report upon the U.S. Geographical Surveys West of the One Hundredth Meridian in charge of First Lieutenant Geo. M. Wheeler." Vol. vii. "Archæology." (Washington, 1879.)

review of cranial measurements. The material seems insufficient and fragmentary, and affords imperfect means for judging in a satisfactory way of the exact status and organisation of these people. A final contribution to the linguistics of the subject, by A. S. Gatschet, closes the volume, with a compendious statement of the relations of the tribes of the western coast with a list of forty vocabularies of western languages.

Finally, this handsome volume, in typography, paper, and illustrations, is of irreproachable beauty, and it treats of a field in archæological study of deep interest and wide import. L. P. GRATACAP

THE SIZE OF ATOMS[1]

II.

IN making brass, if we mix zinc and copper together we find no very manifest signs of chemical affinity at all; there is not a great deal of heat developed: the mixture does not become warm, *it does not explode.* Hence we can infer certainly that contact-electricity action ceases, or does not go on increasing according to the same law, when the metals are subdivided to something like 1/100,000,000 of a centimetre. Now this is an exceedingly important argument. I have more decided data as to the actual magnitude of atoms or molecules to bring before you presently, but I have nothing more decided in *giving for certain a limit to supposable smallness.* We cannot reduce zinc and copper beyond a certain thickness without putting them into a condition in which they lose their properties as wholes, and in which, if put together, we should *not* find the same attraction as we should calculate upon from the thicker plates. I think it is impossible consistently with the knowledge we have of chemical affinities and of the effect of melting zinc and copper together, to admit that a piece of copper or zinc could be divided to a thinness of much less, if at all less, than 1/100,000,000 of a centimetre without separating the atoms or dividing the molecules, or doing away with the composition which constitutes as a whole the solid metal. In short, the structure as it were of bricks, or molecules, or atoms, of which copper and zinc are built up; cannot be much, if at all, less than 1/100,000,000 of a centimetre in diameter, and may be considerably greater.

I will now read you a statement from an article which was published thirteen years ago in NATURE.[2]

"Now let a second plate of zinc be brought by a similar "process to the other side of the plate of copper; a second "plate of copper to the remote side of this second plate of "zinc, and so on till a pile is formed consisting of 50,001 "plates of zinc and 50,000 plates of copper, separated by "100,000 spaces, each plate and each space 1/100,000 of "a centimetre thick. The whole work done by electric "attraction in the formation of this pile is two centimetre-"grammes.

"The whole mass of metal is eight grammes. Hence "the amount of work is a quarter of a centimetre-gramme "per gramme of metal. Now 4030 centimetre-grammes of "work, according to Joule's dynamical equivalent of heat, "is the amount required to warm a gramme of zinc or "copper by one degree Centigrade. Hence the work done "by the electric attraction could warm the substance by "only 1/16,120 of a degree. But now let the thickness of "each piece of metal and of each intervening space be "1/100,000,000 of a centimetre instead of 1/100,000. "The work would be increased a millionfold unless "1/100,000,000 of a centimetre approaches the small-"ness of a molecule. The heat equivalent would therefore "be enough to raise the temperature of the material by "62°. This is barely, if at all, inadmissible, according to "our present knowledge, or, rather, want of knowledge, "regarding the heat of combination of zinc and copper. "But suppose the metal plates and intervening spaces to "be made yet four times thinner, that is to say, the thick-"ness of each to be 1/400,000,000 of a centimetre. The "work and its heat equivalent will be increased sixteen-"fold. It would therefore be 990 times as much as that "required to warm the mass by 1° C., which is very much "more than can possibly be produced by zinc and copper "in entering into molecular combination. Were there in "reality anything like so much heat of combination as this, "a mixture of zinc and copper powders would, if melted in "any one spot, run together, generating more than heat "enough to melt each throughout; just as a large quantity "of gunpowder if ignited in any one spot burns throughout "without fresh application of heat. Hence plates of zinc "and copper of 1/300,000,000 of a centimetre thick, "placed close together alternately, form a near approxima-"tion to a chemical combination, if indeed such thin plates "could be made without splitting atoms."

Similar conclusions result from that curious and most interesting phenomenon, the soap-bubble. Philosophers old and young who occupy themselves with soap-bubbles, have one of the most interesting subjects of physical science to admire. Blow a soap-bubble and look at it, —you may study all your life perhaps and still learn lessons in physical science from it. You will now see on the screen the image of a soap-film in a ring of metal. The light is reflected from the film filling that ring, and focused on the screen. It will show, as you see, colours analogous to those of Newton's rings. As you see the image it is upside down. The liquid streams down (up in the image) and thins away from the highest point of the film. First we see that brilliant green colour. It will become thinner and thinner there, and will pass through beautiful gradations of colour till you see, as now, a deep red, then much lighter, till it becomes a dusky, yellowish white, then green, and blue, and deep violet, and lastly black, but after you see the black spot it very soon bursts. The film itself seems to begin to lose its tension, when it gets considerably less than a quarter of the wave-length of yellow light, which is the thickness for the dusky white, preceding the final black. When you are washing your hands, you may make and deliberately observe a film like this, in a ring formed by the forefingers and thumbs of two hands, and watch the colours. Whenever you begin to see a black spot or several black spots, the film soon after breaks. The film retains its strength until we come to the black spot, where the thickness is clearly much less than 1/60,000 of a centimetre, which is the thickness of the dusky white.

Newton, in the following passage in his "Optics" (pp. 187 and 191 of edition 1721, Second Book, Part I.), tells more of this important phenomenon of the black spot, than is known to many of the best of modern observers.

"Obs. 17.—If a bubble be blown with water, first made "tenacious by dissolving a little soap in it, it is a common "observation that after a while it will appear tinged with a "variety of colours. To defend these bubbles from being "agitated by the external air (whereby their colours are "irregularly moved one among another so that no accurate "observation can be made of them), as soon as I had "blown any of them I covered it with a clear glass, and by "that means its colours emerged in a very regular order, "like so many concentric rings encompassing the top of "the bubble. And as the bubble grew thinner by the con-"tinual subsiding of the water, these rings dilated slowly "and overspread the whole bubble, descending in order to "the bottom of it, where they vanished successively. In "the meanwhile, after all the colours were emerged at the "top, there grew in the centre of the rings a small round "black spot like that in the first observation, which con-"tinually dilated itself, till it became sometimes more than

[1] A lecture delivered by Sir William Thomson at the Royal Institution, on Friday, February 2. Revised by the Author. Continued from p. 205.

[2] See article "On the Size of Atoms," published in NATURE, vol. i. p. 551; printed in Thomson and Tait's "Natural Philosophy," second edition, 1883, vol. i. part 2, Appendix F.

"one-half or three-quarters of an inch in breadth before the "bubble broke. At first I thought there had been no light "reflected from the water in that place, but observing it "more curiously I saw within it several smaller round "spots, which appeared much blacker and darker than the "rest, whereby I knew that there was some reflection at the "other places which were not so dark as those spots. And "by farther trial I found that I could see the images of "some things (as of a candle or the sun) very faintly re- "flected, not only from the great black spot, but also from "the little darker spots which were within it.

"Obs. 18.—If the water was not very tenacious, the "black spots would break forth in the white without any "sensible intervention of the blue. And sometimes they "would break forth within the precedent yellow, or red, "or perhaps within the blue of the second order, before "the intermediate colours had time to display themselves."

Now I have a reason, an irrefragable reason, for saying that the film cannot keep up its tensile strength to 1/100,000,000 of a centimetre, and that is, that the work which would be required to stretch the film a little more than that, would be enough to drive it into vapour.

The theory of capillary attraction shows, that when a bubble—a soap-bubble for instance—is blown larger and larger, work is done by the stretching of a film which resists extension, as if it were an elastic membrane with a constant contractile force. This contractile force is to be reckoned as a certain number of units of force per unit of breadth. Observation of the ascent of water in capillary tubes, shows that the contractile force of a thin film of water, is about sixteen milligrammes weight per millimetre of breadth. Hence the work done in stretching a water film to any degree of thinness, reckoned in millimetre-milligrammes, is equal to sixteen times the number of square millimetres by which the area is augmented, provided the film is not made so thin that there is any sensible diminution of its contractile force. In an article "On the Thermal Effect of Drawing out a Film of Liquid," published in the *Proceedings* of the Royal Society for April, 1858, I have proved from the second law of thermodynamics that about half as much more energy, in the shape of heat, must be given to the film, to prevent it from sinking in temperature while it is being drawn out. Hence the intrinsic energy of a mass of water in the shape of a film kept at constant temperature, increases by twenty-four milligramme-millimetres for every square millimetre added to its area.

Suppose then a film to be given with a thickness of a millimetre, and suppose its area to be augmented ten thousand and one fold: the work done per square millimetre of the original film, that is to say, per milligramme of the mass, would be 240,000 millimetre-milligrammes. The heat equivalent of this is more than half a degree Centigrade (0·57°) of elevation of temperature of the substance. The thickness to which the film is reduced on this supposition, is very approximately 1/10,000 of a millimetre. The commonest observation on the soap-bubble, shows that there is no sensible diminution of contractile force, by reduction of the thickness to 1/10,000 of a millimetre; inasmuch as the thickness which gives the first maximum brightness, round the black spot seen where the bubble is thinnest, is only about 1/8,000 of a millimetre.

The very moderate amount of work shown in the preceding estimates, is quite consistent with this deduction. But suppose now the film to be farther stretched, until its thickness is reduced to 1/10,000,000 of a millimetre (1/100,000,000 of a centimetre). The work spent in doing this is two thousand times more than that which we have just calculated. The heat equivalent is 280 times the quantity required to raise the temperature of the liquid by one degree Centigrade. This is far more than we can admit as a possible amount of work done in the extension of a liquid film. It is more than half the amount of work, which if spent on the liquid, would convert it into vapour at ordinary atmospheric pressure. The conclusion is unavoidable, that a water-film falls off greatly in its contractile force, before it is reduced to a thickness of 1/10,000,000 of a millimetre. It is scarcely possible, upon any conceivable molecular theory, that there can be any considerable falling off in the contractile force, as long as there are several molecules in the thickness. It is therefore probable that there are not several molecules in a thickness of 1/10,000,000 of a millimetre of water.

Now when we are considering the subdivision of matter, look at those beautiful colours which you see in this little casket, left, I believe, by Prof. Brand to the Royal Institution. It contains polished steel bars, coloured by having been raised to different degrees of heat, as in the process of annealing hard-tempered steel. These colours, produced by heat on other polished metals besides steel, are due to thin films of transparent oxide, and their tints, as those of the soap-bubble and of the thin space of air in "Newton's rings," depend on the thickness of the film, which, in the case of oxidisable metals, forms by combination with the oxygen of the air, under the influence of heat—a true surface-burning.

You are all familiar with the brilliant and beautifully distributed fringes of heat-colours on polished steel grates and fire-irons, escaping that unhappy rule of domestic æsthetics, which too often keeps those articles glittering and cold and useless, instead of letting them show the exquisite play of warm colouring, naturally and inevitably brought out, when they are used in the work which is their reason for existence. The thickness of the film of oxide which gives the first perceptible colour, a very pale orange or buff tint, due to the enfeeblement or extinction of violet light and enfeeblement of blue, and less enfeeblement of the other colours in order, by interference of the reflections from the two surfaces of the film, is about 1/100,000 of a centimetre, being something less than a quarter wave-length of violet light in the oxide.

The exceedingly searching and detective efficacy of electricity comes to our aid here, and by the force as it were spread through such a film, proves to us the existence of the film when it is considerably thinner than that 1/100,000 of a centimetre, when in fact it is so very thin as to produce absolutely no perceptible effect on the reflected light, that is to say, so thin as to be absolutely invisible. If in the apparatus for measuring contact electricity, of which the drawing is before you (NATURE, vol. xxiii. p. 567), two plates of freshly polished copper be placed in the Volta condenser, a very perfect zero of effect is obtained. If, then, one of the plates be taken out, heated slightly by laying it on a piece of hot iron, and then allowed to cool again and replaced in the Volta condenser, it is found that negative electricity becomes condensed on the surface thus treated, and positive electricity on the bright copper surface facing it, when the two are in metallic connection. If the same process be repeated with somewhat higher temperatures, or somewhat longer times of exposure to it, the electrical difference is augmented. These effects are very sensible before any perceptible tint appears on the copper surface as modified by heat. The effect goes on increasing with higher and higher temperatures of the heating influence, until oxide-tints begin to appear, commencing with buff, and going on through a ruddier colour to a dark-blue slate colour, when no farther heating seems to augment the effect. The greatest contact-electricity effect which I thus obtained between a bright freshly polished copper surface and an opposing face of copper, rendered almost black by oxidation, was such as to require for the neutralising potential in my mode of experimenting[1] about one-half of the potential of a Daniell's cell.

[1] First described in a letter to Joule, published in the *Proceedings* of the Literary and Philosophical Society of Manchester of Jan. 21, 1862, where also I first pointed out the demonstration of a limit to the size of molecules from measurements of contact electricity. The mode of measurement is more fully described in the article of NATURE (vol. xxiii. p. 567), referred to above.

Some not hitherto published experiments with polished silver plates, which I made fifteen years ago, showed me very startlingly, an electric influence from a quite infinitesimal whiff of iodine vapour. The effect on the contact-electricity quality of the surface, seems to go on continuously from the first lodgment, to all other tests quite imperceptible, of a few atoms or molecules of the attacking substance (oxygen, or iodine, or sulphur, or chlorine, for example), and to go on increasing until some such thickness as 1/30,000 or 1/40,000 of a centimetre is reached by the film of oxide or iodide, or whatever it may be that is formed.

The subject is one that deserves much more of careful experimental work and measurement than has hitherto been devoted to it. I allude to it at present to point out to you how it is that by this electric action, we are enabled as it were to sound the depth, of the ocean of molecules attracted to the metallic surface, by the vapour or gas entering into combination with it.

When we come to thicknesses of considerably less than a wave-length, we find solid metals becoming transparent. Through the kindness of Prof. Dewar, I am able to show you some exceedingly thin films, of measured thicknesses of platinum, gold, and silver, placed on glass plates. The platinum is of $1\cdot9 \times 10$ thickness, and is quite opaque;

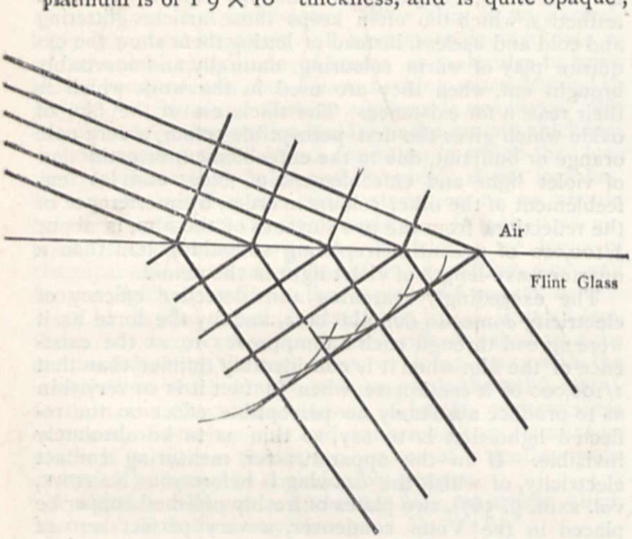


FIG. 3.—Diagram of Huyghen's construction for wave front of refracted light. Drawn for light passing from air to flint glass.

but here is a gold film of about the same thickness, which is transparent to the electric light, as you see, and transmits the beautiful green colour, which you see on the screen. The thickness of this gold (1·9, or nearly 2) is just half the wave-length of violet light in air. This transparent gold, transmitting green light to the screen as you see, at the same time reflects yellow light to the ceiling. Now I will show you the silver. It is thinner, being only $1\cdot5 \times 10^{-5}$ of a centimetre thick, or 3/8 of the air-wave-length of violet light. It is quite opaque to the electric light, so far as our eyes allow us to judge, and reflects all the light up to the ceiling. It is not wonderful that it should be opaque; we might wonder if it were otherwise; but there is an invisible ultra-violet light of a small range of wave-lengths, including a zinc-line of air wave-length $3\cdot4 \times 10^{-5}$, which this silver film transmits. For that particular light the silver film of $1\cdot5 \times 10^{-5}$ thickness is transparent. The image which you now see on the screen, is a magic lantern representation of the self-photographed spectrum, of light that actually came through that silver. You see the zinc-line very clear across it near its middle. Here then we have gold and silver transparent. The silver is opaque for all except that very definite light of wave-lengths from about 3·07 to 3·32.

The different refrangibility of different colours, is a result of observation, of vital importance in the question of the size of atoms. You now see on the screen before you a prismatic spectrum; a well-known phenomenon produced by the differences of the refractions of the different colours, in traversing the prism. The explanation of it in the undulatory theory of light, has taxed the powers of mathematicians to the utmost. Look first, however, to what is easy, and made clear by that diagram (Fig. 3) before you; and you will easily understand that refraction depends on difference of velocity of propagation of light, in the two transparent mediums concerned. The

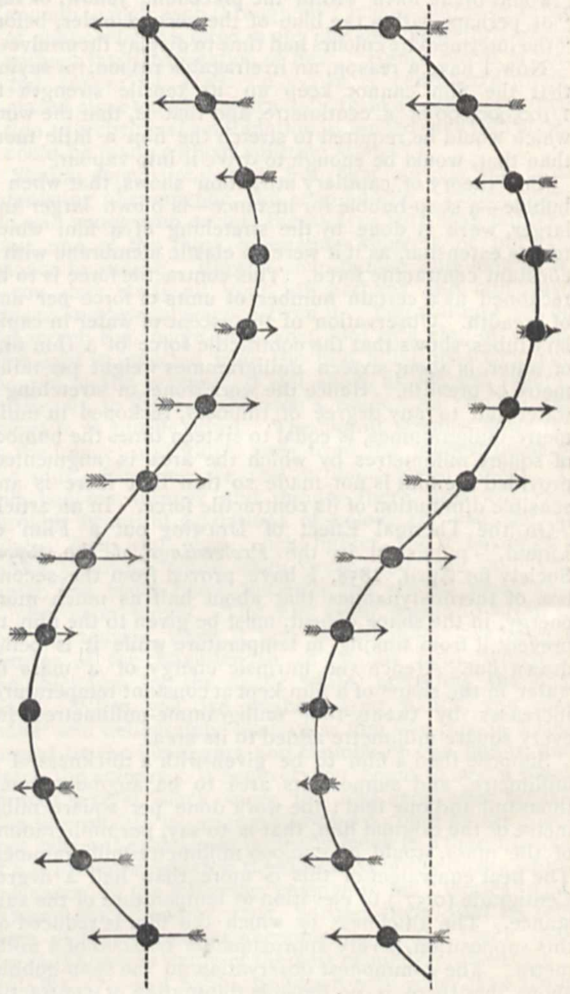


FIG. 4. FIG. 5.
Twelve particles in Wave-Length.

angles in the diagram are approximately correct, for refraction at an interface between air or vacuum and flint glass; and you see that in this case, the velocity of propagation is less in the denser medium. The more refractive medium (not always the denser) of the two, has the less velocity for light transmitted through it. The "refractive index" of any transparent medium, is the ratio of the velocity of propagation in the ether, to the velocity of propagation in the transparent substance.

Now, that the velocity of the propagation of light should be different in different mediums, and should in most cases be smaller in the denser than in the less dense medium, is quite what we should, according to dynamical principles, expect from any conceivable constitution of the luminiferous ether and of palpable transparent substance. But that the velocity of propagation in any one transparent substance, should be different for light of different colours, that is to say, of different periods of vibration, is not what we should expect; and could not possibly be the fact if the medium is homogeneous, without any limit as to the smallness of the parts of which the qualities are compared. The fact that the velocity of propagation *does* depend on the period, gives what I believe to be irrefragable proof, that the substance of palpable transparent matter, such as water, or glass, or the bisulphuret of carbon of this prism whose spectrum is before you, is not infinitely homogeneous; but that on the contrary, if contiguous portions of any such medium, any medium in fact which can give the prismatic colours, be examined at intervals not incomparably small in comparison with the wave-lengths, utterly heterogeneous quality will be discovered; such heterogeneousness as that which we understand in palpable matter, as the difference between solid and fluid; or between substances differing enormously in density; or such heterogeneousness as differences of velocity and direction of motion, in different positions of a vortex ring in an homogeneous liquid; or such differences of material occupying the space examined, as we find in a great mass of brick building when we pass from brick to brick through mortar (or through *void*, as we too often find in Scotch-built domestic brick chimneys).

Cauchy was I believe the first of mathematicians or naturalists, to allow himself to be driven to the conclusion, that the refractive dispersion of light can only be accounted for, by a finite degree of molecular coarse-grainedness, in the structure of the transparent refracting matter; and as, however we view the question, and however much we may feel compelled to differ, from the details of molecular structure and molecular inter-action assumed by Cauchy, we remain more and more surely fortified in his conclusion, that finite grainedness of transparent palpable matter, is the cause of the difference of the velocity of different colours of light propagated through it, we must regard Cauchy as the discoverer of the dynamical theory of the prismatic colours.

But now we come to the grand difficulty of Cauchy's theory;[1] look at this little table (Table II.), and you will see

TABLE II.—*Velocity* (*V*) *according to Number* (*N*) *of Particles in Wave Length*

N	$V\left(=100\,\frac{\sin(\pi/N)}{\pi/N}\right)$
2	63·64
4	90·03
8	97·45
12	98·86
16	[illegible]·36
20	99·59
∞	100·00

in the heading, the formula which gives the velocity, in terms of the number of particles to the wave-length, supposing the medium to consist of equal particles arranged in cubic order, and each particle to attract its six nearest neighbours, with a force varying directly as the excess of the distance between them, above a certain constant line (the length of which is to be chosen, according to the degree of compressibility possessed by the elastic solid, which we desire to represent by a crowd of mutually interacting molecules). If you suppose particles of real matter arranged in the cubic order, and six steel wire spiral springs or elastic indiarubber bands, to be hooked on to each particle and stretched between it and its six nearest neighbours, the postulated force may be produced in a model with all needful accuracy; and if we could but successfully wish the theatre of the Royal Institution, conveyed to the centre of the earth, and kept there for five minutes, I should have great pleasure in showing you a model of an elastic solid thus constituted, and showing you waves propagated through it, as are waves of light in the luminiferous ether. Gravity is the inconvenient accident of our actual position, which prevents my showing it to you here just now. But instead, you have these two wave-models (see Fig. 2 above), each of which shows you the displacements and motions of a

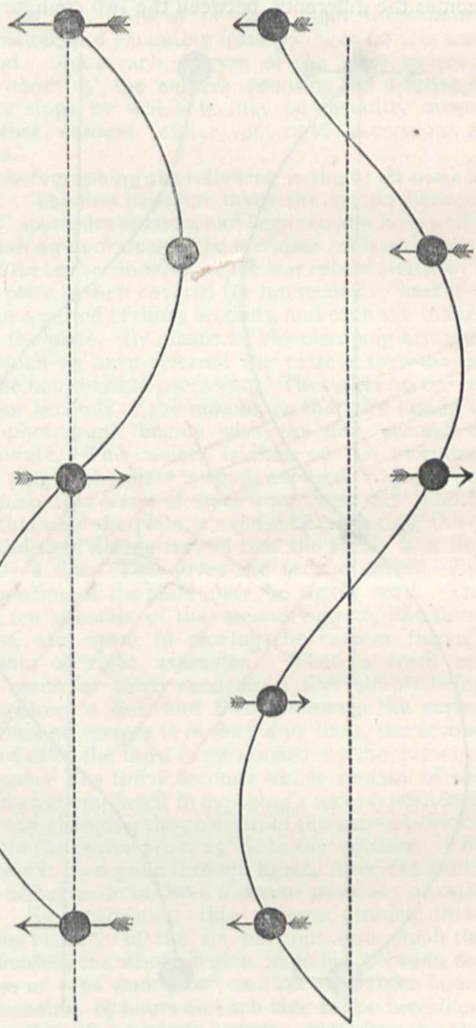


FIG. 6. FIG. 7.
Four particles in Wave-Length.

line of particles, in the propagation of a wave through our imaginary three-dimensional solid; the line of molecules chosen being those which, in equilibrium, are in one direct straight line of the cubic arrangement, and the supposed wave having its wave front perpendicular to this line, and the direction of its vibration, the direction of one of the other two direct lines of the cubic arrangement.

You have also before you this series of diagrams (Figs. 4 to 9) of waves in a molecularly-constituted elastic solid. These two diagrams (Figs. 4 and 5) illustrate a wave in which there are twelve molecules in the wave-length; this one (Fig. 4) showing (by the length and position of the arrows) the magnitude and direction of velocity of each molecule, at the instant when one of the

[1] For an account of the dynamical theory of the "Dispersion of Light," see "View of the Undulatory Theory as Applied to the Dispersion of Light," by the Rev. Baden Powell, M.A., &c. (London: 1841)

molecules is on the crest of the wave, or has reached its maximum displacement; that one (Fig. 5) showing the magnitude and direction of the velocities, after the wave has advanced such a distance, as (in this case equal to one-twenty-fourth of the wave-length) to bring the crest of the wave to midway between two molecules. This pair of diagrams (Figs. 6 and 7) shows the same for waves having four molecules in the wave-length, and this pair (Figs. 8 and 9) for a wave having two molecules in the wave-length.

The more nearly this critical case is approached, that is to say the shorter the wave-length, down to the limit of twice the distance from molecule to molecule, the less becomes the difference between the two configurations of

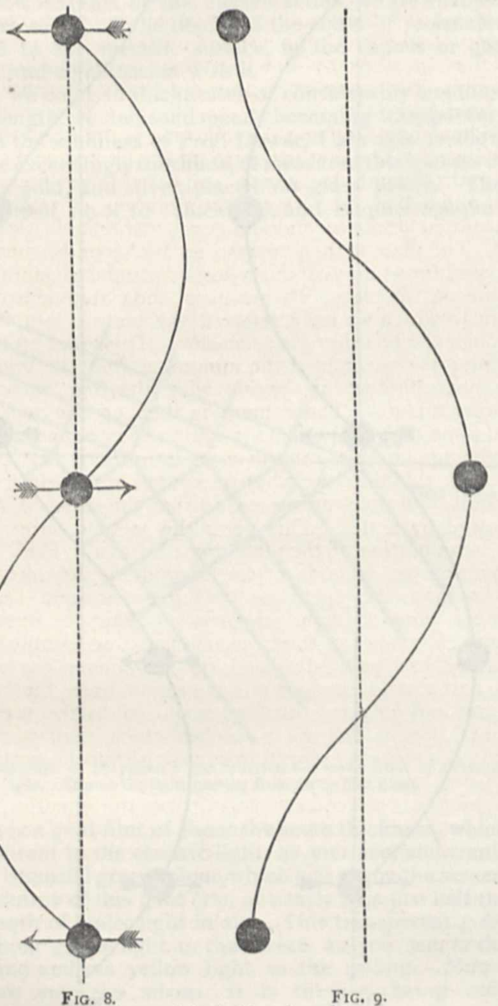


Fig. 8. Fig. 9.
Two particles in Wave-Length.

motion, constituted by waves travelling in opposite directions. In the extreme or critical case, the difference is annulled, and the motion is not a wave-motion, but a case of what is often called "standing vibration." Before I conclude this evening, I hope to explain in detail the kind of motion which we find instead of wave-motion (become mathematically imaginary), when the vibrational period of the exciter is anything less than the critical value; because this case is of extreme importance and interest in physical optics, according to Stokes' hitherto unpublished explanation of phosphorescence.

This supposition of each molecule acting with direct force only on its nearest neighbour, is not exactly the postulate on which Cauchy works. He supposes each molecule to act on all around it, according to some law of rapid decrease as the distance increases; but this must make the influence of coarse-grainedness on the velocity of propagation smaller than it is on the simple assumption, realised in the models and diagrams before you, which therefore represents the extreme limit of the efficacy of Cauchy's unmodified theory to explain dispersion.

Now, by looking at the little table (Table II.) of calculated results, you will see that with as few as 20 molecules in the wave-length, the velocity of propagation is 99½ per cent. of what it would be with an infinite number of molecules; hence the extreme difference of propagational velocity, accountable for by Cauchy's unmodified theory in its idealised extreme of mutual action limited to nearest neighbours, amounts to 1/200. Now look at this table (Table III.) of refractive indices, and you see that the difference of velocity of red light (A), and of violet light (H), amounts in carbon disulphide to 1/17; in dense flint glass to nearly 1/30; in hard crown glass to 1/73; and in water and alcohol to rather more than 1/100. Hence, none of these substances can have so many as 20 molecules in the wave-length, if dispersion is to be accounted for by Cauchy's unmodified theory, and by looking back to the little table of calculated results (Table II.), you will

Table III.—*Table of Refractive Indices.*

Line of Spectrum.	Material.				
	Hard Crown Glass.	Extra dense Flint Glass.	Water at 15° C.	Carbon Disulphide at 11° C.	Alcohol at 15° C.
A	1·5118	1·6391	1·3284	1·6142	1·3600
B	1·5136	1·6429	1·3300	1·6207	1·3612
C	1·5146	1·6449	1·3307	1·6240	1·3621
D	1·5171	1·6504	1·3324	1·6333	1·3638
E	1·5203	1·6576	1·3347	1·6465	1·3661
b	1·5210	1·6591	—	—	—
F	1·5231	1·6442	1·3366	1·6584	1·3683
G	1·5283	1·6770	1·3402	1·6836	1·3720
h	1·5310	1·6836	—	—	—
H	1·5328	1·6886	1·3431	1·7090	1·3751

The numbers in the first two columns were determined by Dr. Hopkinson, those in the last three by Messrs. Gladstone and Dale. The index of refraction of air for light near the line E is 1·000294.

see that there could not be more than twelve molecules in the wave-length of violet light in water or alcohol; say ten in hard crown glass; eight in flint glass; and in carbon disulphide actually not more than four molecules in the wave-length, if we are to depend upon Cauchy's unmodified theory for the explanation of dispersion. So large coarse-grainedness of ordinary transparent bodies, solid or fluid, is quite untenable. Before I conclude I intend to show you, from the kinetic theory of gases, a *superior limit* to the size of molecules, according to which, in glass or in water, there is probably something like 600 molecules to the wave-length; and almost certainly *not fewer* than two, or three, or four hundred. But even without any such definite estimate of a superior limit to the size of molecules, there are many reasons against the admission that it is probable or possible, there can be only four, or five, or six to the wave-length. The very drawing by Nobert of 4,000 lines on a breadth of a millimetre, or at the rate of 40,000 to the centimetre, or about two to the ether wave-length of blue (F) light,[1] seems quite to negative the idea of any such possibility, of only five or six molecules to the wave-length, even if we were not to declare against it from theory and observation of the reflection of light from polished surfaces.

(*To be continued.*)

[1] Loschmidt, "quoting from the Zollvereins department of the London International Exhibition of 1862, page 83. and from Harting 'On the Microscope,' page 881," *Sitzungsberichte der Wiener Akademie Math. Phys.* 1865. vol. iii.

STELLAR PHOTOGRAPHY AT HARVARD

AT the meeting of the Astronomical Society which was held on June 8 last, Prof. Pickering of Harvard College Observatory, so well known for his stellar observations, and who is a Foreign Associate of the Society, attended and gave an interesting account of the work which has been done during the past few years at his observatory.

Some few years ago Prof. Pickering took up the work of determining the intensity of the light of the principal stars by eye observation, without taking the question of colour into consideration, work which has been already dwelt upon in this journal. For this purpose he used a photometer, completing his observations, which number some 90,000, about a year ago, and a large part of his results are already in print. The published results of the more important investigators of star magnitudes, from the time of Almagest and Lûfi, have also been reduced. Sir W. Herschel's observations, which appeared almost a century ago in the *Philosophical Transactions*, have likewise been taken in hand at Harvard Observatory and completely discussed. Sir John Herschel's works, the "Uranometria Nova," the "Durchmusterung," as well as many other works in the same field, have also been made use of in preparing the Harvard Catalogue, which therefore shows those cases in which the photometric observations carried out by Prof. Pickering differ from the results obtained by other observers, when their observations are reduced to the same system. These eye observations of stars having been completed, Prof. Pickering, in conjunction with his brother, Mr. W. H. Pickering, has taken up stellar photography from the same point of view. By this means a comparison is obtained between the brightness of the star as seen by the eye, and its brightness as determined by its greater or less action upon the photographic plate; and by a comparison of photographs taken on different nights any variation in brightness may be detected; whilst the exact positions of stars may of course be more accurately and permanently recorded than by eye observations. Mr. A. A. Common recently, by taking photographs of the nebula in Orion on different nights and comparing them, has thus been able to detect a probable variation in one of the stars in the nebula, and in 1858 Professor George P. Bond, by measuring the diameters of stars in photographs was able to determine the relative brightness of the two stars which form the double ζ Ursæ Majoris.

But the work at Harvard University was to do more than this. The stars which Prof. Bond examined were close together. Prof. Pickering wished to compare stars far removed from each other. For this purpose the ordinary method of stellar photography, by which photographs are taken at the foci of large telescopes, would not suffice. These photographs only comprise a small region of but one or two degrees in diameter. A different method was therefore employed in the Harvard observations. A wholly different form to the ordinary equatorial telescope was used. It is not unusual to construct photographic cameras to take pictures of buildings which subtend an angle of 60° or even 90°. But when applied to the stars, however, the images at the edges are very poor, and only very small apertures can be used. It has, however, been found that some of the best lenses for pictures can be obtained covering a circle of 20° diameter without serious distortion, and at the same time large apertures can be used, thus reducing the time of exposure. In order to still further this work, Mr. W. H. Pickering investigated the sensitiveness of various photographic plates, and obtained some so sensitive that stars of the fifth and sixth magnitude have been photographed without using clockwork, they forming dots or making lines, as their images pass across the photographic plate, the length of these lines depending of course upon the time during which the plate is exposed. If the plate be exposed during ten seconds a distinct dot is obtained, whilst an exposure of thirty seconds causes a short line to be formed. The plates used at Harvard Observatory are six by eight inches. They are divided into six equal parts, each part being in turn exposed. By this means six regions of the heavens, each about 15° square, may be photographed on one plate; and by a variation in the dot and line system employed, sometimes taking the dot and sometimes the line first, three pictures may be taken on a single division of one of the plates without giving rise to any confusion. Instead of simply six, therefore, eighteen photographs are taken on one of these plates, so that on a single plate a portion of the heavens of more than three hours' right ascension, and extending from 30° S. to 60° N., may be included. Since each portion of the plate covers a region of about 15°, the camera mounting has a series of notches or stops, by which it may be instantly moved through that amount either of right ascension or declination.

When photographing the following is the exact method employed. The first exposure takes the region between 30° and 15° south declination, and between one hour and a half and half an hour west of the meridian. First the plate is exposed for ten seconds, and each star records itself by a dot. The plate is then covered for ten seconds; next it is exposed for a period of thirty seconds, and each star makes a line on the plate. By means of the clamping arrangement to which we have referred the plate is then moved through one hour in right ascension. This takes up the remaining few seconds of the minute, so that the taking of the next photograph begins with the first second of another minute. The camera is then on the meridian. The same part of the plate is again exposed, and in order to distinguish this series of stars from those first photographed, this time the plate is exposed first during thirty seconds, and then during ten, so that the result is a line followed by a dot. This gives the second series. But the same portion of the plate may be again used. The remaining ten seconds of the second minute, like those of the first, are spent in moving the camera through another hour of right ascension. Then a fresh exposure is made for thirty seconds, a line simply being obtained without a dot, and this completes the series. The first class of images is in dots and lines, the second in lines and dots, the third is recognised by the presence of lines alone. The thirty seconds which remain of the third minute are employed in exposing a second portion of the plate, and changing the position of the camera, which now takes in the region from 15° S. to the equator. The same process is then gone through again, three exposures as before being made in three different positions of right ascension. By continuing this process, taking three photographs on each of the six portions into which the plate is divided, the whole region included between the declinations of $-30°$ and $+60°$, and between three hours of right ascension, $1\frac{1}{2}$ hours on each side of the meridian, being one-eighth of the whole heavens, excluding the circumpolar stars, will be photographed on one plate, the whole operation occupying but eighteen minutes. With regard to those stars in the vicinity of the Pole, some other method will have to be adopted. Thus much for one branch of the work—and an important branch—carried on at Harvard Observatory.

Another portion of their work consists in the preparation of a photographic map of the entire heavens. The method just described, in which clockwork is dispensed with, only enables those stars whose magnitude is not less than five or six to be photographed, and stars of a less magnitude than this must of course be included in a map of the heavens. The camera in this work, therefore, is driven by clockwork. By this means stars of the eighth magnitude record their images on the photographic plate, and as many as 200 are visible in the paper print within a circle of 5° in diameter. A photograph taken in this way of a portion of the constellation of Orion, besides showing the three stars of the Belt and the Sword-Handle, gives an interesting picture of the nebula.

With reference to the question of the colours of stars it is interesting to note the faintness of α Orionis in the photographs. To the eye its brilliancy is almost as great as that of β, whilst in the photograph it is not more prominent than λ. The reason is to be found in the colour of α. It is a red star, and consequently makes but little impression on the photographic plate.

Again, in the constellation Cetus the three stars which are brightest to the eye are α, γ, and δ. A, which is the brightest of the three, has close to it a very faint companion, scarcely visible to the naked eye, its magnitude being given as 6·3, whilst that of α is 2·7. This is the appearance of this part of that constellation as seen by the eye. A photograph of this region was taken at Harvard with the result that the small star is seen in the photograph nearly as bright as α, it being only three-tenths of a magnitude less. The colour of these stars again explains this, α being of a reddish tint, whilst the small star is of a deep blue colour, and being so the rays which flow from it have a greater influence on the photographic plate. A comparison of the number of stars seen in the photograph of Orion with the number in the photometric catalogue, further illustrates this effect of colour. In that part of this constellation included between 5° north and 5° south declination, and 75° to 90° of right ascension, sixteen stars were common to photograph and catalogue; a like number, being either too small in magnitude or too red in colour, although catalogued, remain unrecorded on the photographic plate; whilst five others seen in the photograph are not given in the catalogue. A reduction has been made of the results given by the plates of different makers, with the view of ascertaining the value of the deviation. In two of such plates the average deviation was 0·21 of a magnitude, and in two measurements of the same plate it was found to be 0·07 of a magnitude.

It is obvious from this account of the work at Harvard that star photography is entering into a new phase, and one which will entirely replace the present system of eye observations, for the reason that, whilst the eye is so variable, photographic plates may now be obtained, doing their work with almost definite wave-lengths of light. The constant record of the plate, must in time therefore be preferred to observation by the variable eye. At the same time as photography advances, if it be considered necessary to obtain photographic star maps to record the observations of the average eye, there will be no difficulty in this being done.

NOTES

IN accordance with the provisions of the Statutes, the Council of the Royal Society met last Thursday to elect one from among themselves to fill the office of president until the annual election on November 30. The choice, as had been anticipated, fell upon Prof. Huxley. We believe that this *ad interim* election has given the greatest satisfaction to all the Fellows of the Society.

WE have received from the Johns Hopkins University, Baltimore, the circular giving the programme for the next academic year and a report on the work of the year that is past. Not only are a great number of subjects included in the programme of this University, but provision is made that the work in each section shall be thoroughly done, and we think the Trustees are to be entirely congratulated upon the progress that is being made. Among the scientific subjects we find physics, chemistry, geology, mineralogy, and biology in all its branches. With the other subjects which the programme sets forth we have here of course little to do, but we must add that we are glad to note under the heading "Philosophy" that the study of psychology is well provided for. Not only are there courses of lectures, but a limited number of the students are provided with seats in the physiological laboratory, where they may prosecute original research. It is so in all the scientific subjects. The work of the advanced student is arranged with a view of initiating him into the methods of original investigation, which, when he has finished his course of instruction, he is encouraged to carry on. Thus in the physical laboratory, which is under the direction of Prof. Rowland and Dr. Hastings, during the past year original investigations have been carried on in many parts of the subject; for instance, to name one or two, the concave grating has been used in an attempt to photograph the spectrum, and with it an endeavour has also been made to ascertain the wave-lengths of the lines. The unit of electrical resistance has also been investigated during the past year, and during the coming session an attempt will be made to establish an international unit for such resistance. We notice too, as a feature of the advanced course in physics conducted by Prof. Rowland, that besides the lectures and laboratory work there are weekly meetings for the discussion of the current literature of the subject. The courses in chemistry, which are under the sole control of Prof. Remsen, are likewise excellent. Besides the ordinary courses in general and analytical chemistry, the programme states that arrangements will soon be made by which the study of applied chemistry—for example, metallurgy, the chemistry of iron and steel, of dye stuffs, of soils and fertilisers—may be taken up by the students. Original research has been a prominent feature in this laboratory also, the results appearing in the *American Chemical Journal*. With regard to mineralogy and geology we notice that they are included in the courses on chemistry. The courses on biology are most excellent, general biology, embryology, osteology, and plant analysis being included in the first year's work. In the second year the student takes up mammalian anatomy, animal physiology and histology, and animal morphology. Then when the student desires to take up the study of marine animals, the University provides him with a laboratory by the sea itself. This laboratory was open last year from May 1 until September 29, and during that time the development of Thallassema was investigated, studies were made with regard to the origin of the oyster-shell, the parthenogenesis of the Echini, the development of Tubularia, and other subjects, which want of space alone prevents our mentioning. The results of these investigations are published in "Studies from the Biological Laboratory"; abstracts of two of these researches have also been printed in the *Proceedings of the Royal Society*, and Dr. E. B. Wilson's paper on the Development of Renilla will appear in the *Philosophical Transactions*. We might add much more to what we have said concerning the excellent character of the work done at this University, as we do not doubt that the other courses are as well provided for as the more purely scientific subjects to which alone we have referred. The Johns Hopkins University, in fact, although but a new institution, has been founded on a broad basis, giving to the student those opportunities for original work which it is so difficult to obtain elsewhere. We should much like to see such an account of original research done and to be done issuing each year from the laboratories of Oxford and Cambridge.

THE Berlin Academy of Sciences has elected Prof. Simon Newcomb (Washington) and Prof. B. Apthorp Gould (director of Cordova Observatory) as corresponding members.

IN our review of the life of Sir Edward Sabine, which appeared in our issue of last week (p. 219), we stated that he accompanied the expedition which under the command of Capt. James Ross was sent to make a magnetical survey of the Antarctic regions. This was an error, as although all the observations were investigated and discussed by him he was not with the expedition, but had the observations forwarded to him at regular intervals.

THE whale which was found by a fisherman in Selsea Bay some six weeks since, and presented to the Brighton Aquarium, is a valuable addition to that establishment. Although undoubtedly belonging to the whale family, competent authorities have pronounced it to be a bottle-nosed dolphin, a creature rarely to be seen alive in an aquarium. It has been placed in a tank which holds 100,000 gallons of water, and is 110 feet in length, so that the animal, which is ten feet long, has some amount of freedom. It seems to be doing quite well, for not only has it not lost in bulk since its capture, but has even gained, weighing now more than eight hundredweight. It is very tame, taking its food from the attendant. At present it subsists upon mackerel, that being the food most easily obtained just now. Of these it takes five meals each day, and manages to eat some 400 of them during a week. The mackerel season is, however, almost over, and some other diet must be found for the animal, perhaps herrings. When first placed in the tank it retreated to one end. After a week's sojourn there, it sought the other end of the tank. Here it remains, swimming in circles. When swimming it keeps close to the surface of the water, moving through it with a graceful undulating movement, coming now and again to the surface, and taking in a fresh supply of air about every third or fourth time it thus rises. The animal is certainly an interesting acquisition to the Aquarium.

THE balloon of the Paris Observatory has been in working order for some weeks. Its capacity being only sixty cubic metres, it was found difficult to use it except in calm weather. The motions of the registering apparatus are an obstacle to correct readings. The experiments, conducted by Admiral Mouchez, are stated to be only preliminary to further aërostatical experiments. The subject is quite new, scientific ballooning being only in its infancy, and it is only by gradual investigation that the extent of the services it can render to science can be ascertained.

A CORRESPONDENT of the *North China Herald* describes a journey from Hankow on the Yangtsze to Chunching in Szechuen, a distance of 720 geographical miles. After passing Ichang, the highest port on the great river opened to foreign trade, the first of the celebrated gorges is entered, and the mountainous country which extends up to and beyond Chunching begins. Through these ranges, which mostly run in a north and south direction, the Yangtsze, here called the Ch'uan Ho, or river of Szechuen, forces its way. Leaving the wild, little-inhabited country of the gorges behind, the traveller, on reaching Wan-hsien, 160 geographical miles above Ichang, emerges into a country of picturesque sandstone hills, at this season covered from base to summit with poppy gardens, with not a vacant spot except where perpendicular cliffs prevent all access. He emerges, too, among a people remarkable for their polished manners and especial politeness to Europeans. While Hupeh province was suffering from floods, the traveller found Eastern Szechuen, from Kweichow to Wan-hsien, praying for rain. The drought here had extended over six months, the south gates of the cities were closed (as facing the *yang* or fire-element), and all slaughtering of animals was forbidden. From Wan-hsien to Chunching, a distance of 200 miles, the aspect of the river remained the same—a succession of winding reaches, nearly all, owing to the peculiar sandstone formation, running at right angles to each other, and united by the customary rapid. Cliffs were frequent, and the sites of the towns and cities, built on steep projecting knolls, their walls and battlements crowning the precipices, are admirable. At length, two months from Shanghai, the traveller reached Chunching, the commercial metropolis of Szechuen, in which, by the Chefoo Convention, the English Government is authorised to maintain a Resident, who watches the commercial prospects and movements of the great provinces of Szechuen and Yunnan.

THE Paris *Figaro* recently published a special supplement on Tonkin, and if the writer is to be credited, that country is one of the richest in the world. Its gold mines, he says, can rival those of California and Australia. The natives use that metal for exchange; the females of the Muongs of the Black River, on their way to and from market, gamble with thousands of francs worth of it, without caring whether they win or lose. The mines of Talan, near Yuen-kiang, on the Red River, were visited by the Commission of the Meikong, who found gold there in bars as well as dust. Still higher, near the source of the Red River, the precious metal is obtained in large quantities. Silver also is not rare, and copper is found everywhere, all the domestic utensils of the people being made of this metal. The tin mines are not worked for want of capital, although those worked near Mong-tsze, in Yunnan, near the Red River, are the most valuable known to exist. Zinc, lead, iron, and bismuth are also known. The coal mines, however, are the most important of all. Tonkin produces also musk, tortoise-shell, mother-of-pearl, wax, silk, peacocks' feathers, as well as those of the blue pheasant, and other birds of brilliant plumage. "In short," concludes the *Figaro*, "it is a rich country, and worth the trouble of occupying it."

ANOTHER trial has been made in Paris of the electric tramcar in which Faure-Sellon-Volckmar accumulators were employed. The experiment was preceded by a lecture given by M. Philippart, tending to show the great economic superiority of electricity over the employment of hor es. On this occasion the route chosen was not, as formerly, from the Place des Nations to La Muette and Trocadéro, but from Trocadéro to the Louvre and thence to the Place des Nations by the Bastille, an alteration made to show the capacity of the electric tramcar for ascending slopes on the common roads.

DR. OBACH has lately perfected his tangent galvanometer with a swinging coil. In the present form the coil is compound, being in reality one for measuring quantity and another for measuring electromotive force. The coil is movable on a horizontal axis, and therefore can be inclined at any angle. It has the advantage over a tangent galvanometer in having a suspended needle which can be rendered dead beat; the coils are also balanced so that the deflection corresponding to one volt with the high resistance coil is that which corresponds with one ampere with the low resistance coil. This instrument promises well for practical testing if made in a convenient portable form.

THE last number of the *Zeitschrift der Gesellschaft für Erdkunde* of Berlin contains a paper by Dr. F. Boas on the former distribution of the Eskimo in the Arctic-American archipelago. After referring to the discovery by Arctic travellers, in places where no human foot appears now to tread, of traces of habitations, graves, weapons, &c., he says that two theories have been broached to account for these remains. One is that the ice has encroached more and more on the sea, and driven away the people; the other that there has been a migration from the west across the archipelago. Dr. Boas rejects both of these explanations. He points out that, judging by the remains, the former inhabitants led precisely the same life as the Eskimo that we know to-day. He comes to the conclusion, after an examination of the various islands, of the distribution of traces of previous inhabitants and of the present tribes, that for numerous reasons we must abandon the theory that there was an earlier extension of inhabitants towards the north. He thinks that the remains found are those of the present tribes who have been driven from place to place by the necessity of obtaining subsistence, and refers to the custom of several tribes to abandon huts in which death has taken place and to leave them standing. The hunting-grounds too would change from time to time according to the severity of the winter. A hard and fast boundary line cannot be laid down for inhabitants of the Arctic regions any more than for the flora. In favourable years plants are carried north and grow until a succession of severe winters again destroys them, and their remains might also lead, in the same way, to the incorrect conclusion that there had been a change in the climate of the region. Similarly with human settlements. The presence of traces of these latter in a given place show, not that the climate has become more severe, but that the place lies in that debatable land between districts favourable and unfavourable to the existence of man. Before any really satisfactory conclusion can be reached, however, he thinks we must have a thorough examination of the migration of the Eskimo; before it is possible to account for the presence of traces of the people in the far north on coasts where they do not now live, we must recollect how their wanderings depend on the physical conditions of life, on the nature of the ground, of the hunting, and the influence of the neighbouring tribes. But on all these points we lack material for a complete explanation of the facts. With respect to the comparatively great age claimed for some of these remains which have been brought by Arctic travellers to Europe, Dr. Boas suggests that all estimates as to the age of objects such as these coming from the Arctic regions must be taken with great care, owing to the different effects of the climate. He instances the remains of Parry's camp at Point Nias in Hecla Bay, which were found looking quite fresh in 1854, more than thirty years after Parry's expedition; while the cairn erected at the same time (1820) on Cape Providence was covered with lichen and moss, and looked quite ancient in 1854.

WE have received the Administration Report of the Meteorological Reporter to the Government of the North-West Provinces and Oudh for the years 1882-83. At the beginning of the present year the observatories reporting to the Allahabad Office were twenty in number, and great activity seems to have been displayed in all of them. The question of the construction of a first class observatory for these provinces has advanced during the present year, but only very slightly. It will in all probability be built at Allahabad. In addition to the ordinary observations, special observations of soil temperatures have been carried on at Allahabad and Jeypore. At Jeypore, where the observatory has practically become one of the first class, all records being made automatically, a sixth soil thermometer has been added to the five which the observatory already possesses to record the temperature at a depth of twenty feet. It is evident from the report that Mr. S. A. Hill, the meteorological reporter, is doing his level best with the means at his command. Unfortunately, however, the native observers still make mistakes, and some of the monthly means require a considerable amount of overhauling.

DR. HENRY MACAULAY, M.D., of Belfast, has recently made a suggestion which, if followed in tropical countries, will turn the tables on the sun with a vengeance. He suggests that Mouchot's sun-engine should be used to pump cold air into dwellings, factories, &c., pointing out that the temperature can in this way be reduced from 100° or more to 60°. He points out that not only will this reduce the temperature especially at night, thus rendering sleep possible, but fresh air will be guaranteed during the day, and the plague of flies and insects would be excluded. The weak point about this arrangement is that it requires ice. We think, however, that sooner or later in America, where the heat in summer is more distressing than in any other part of the world, and ice is everywhere, this arrangement, or one like it, is certain to be adopted.

THE last number of the *Proceedings of the Royal Society of Tasmania* contains several papers on the botany and zoology of Tasmania. In a presidential address the Governor, Sir J. Lefroy, remarks on the omission of any reference to the Botanic Gardens of Hobart Town by Prof. Thiselton Dyer, in a review of the botanical enterprise of the Empire, and demands more public support for these gardens. He notices also a fact which will be of some interest in England just now, viz. that of over ten thousand visitors to the Museum in six months more than half were Sunday visitors. Among the chief papers are:—Notes on a species of Eucalyptus (*E. hæmastoma*), by Mr. Stephens; type species of Tasmanian shells, by Prof. Tate; the magnetic variation of Hobart, by Sir J. Lefroy; notes on *Leontopodium catipes*, by Baron von Müller, &c. With respect to the Sunday opening of the Museum, the Council of the Society report that it is open only between the hours of half-past two and five, "and this arrangement, as will be seen by the number availing themselves of the opportunity, may be pronounced to be no longer an experiment, and to be fully justified by the quiet and orderly demeanour of the visitors."

THE voyage round the world of the Swedish frigate *Vanadis*, which we recently announced, will be shared by the Duke of Gotland, King Oscar's youngest son. The journey, which will be of about eighteen months' duration, will chiefly be a scientific one, several eminent Swedish *savants* participating in the same. From the Straits of Magellan the ship will proceed to the Sandwich Islands, Japan, China, India, and thence home.

THE steamers *Obe* and *Nordenskjöld* left Tromsö for Novaya Zemlya on the 3rd inst. Norwegian fishermen report that the state of the ice in the Arctic Sea east of the North Cape is very favourable this spring.

M. PASTEUR has been appointed head of the Sanitary Commission formed in Paris in view of the dreaded visitation of cholera.

A FRENCH scientific periodical puts forward the idea of a joint occupation of Mecca by the several European powers for the purpose of stopping pilgrimages thither and thereby preventing the further dissemination of cholera through the crowding of people in so pestilential a city, especially when the Ramadan falls in summer.

WE are asked to say that possessors of the eighth edition of Prof. Babington's "Manual of British Botany" may, by application to Mr. Van Voorst, 1, Paternoster Row, obtain gratis two pages of additions and corrections which have been prepared by the author.

LOCUSTS are reported from the south of Russia, but the very energetic measures taken by the Governors for the destruction of the eggs and larvæ will, it is believed, arrest their ravages.

THE additions to the Zoological Society's Gardens during the past week include a Tennant's Squirrel (*Sciurus tennanti*) from Ceylon, presented by Mr. A. Ross; two Rufous Tinamous (*Rhynchotus rufescens*), three Spotted Tinamous (*Nothura maculosa*) from the Argentine Republic, presented by Mr. E. M. Longworthy; two Common Buzzards (*Buteo vulgaris*), British, presented by Mr. James S. Cookson; a Land Rail (*Crex pratensis*), British, presented by Mr. J. W. Merison; a Jackdaw (*Corvus monedula*), British, presented by Mr. J. Baldwin; two Cockateels (*Calopsitta novæ-hollandiæ*) from Australia, presented by Mrs. Day; three Angulated Tortoises (*Testudo angulata*), a Geometric Tortoise (*Testudo geometrica*), an Areolated Tortoise (*Testudo areolatus*), a Robben Island Snake (*Coronella phocarum*), a Laland's Ground Snake (*Typhlops lalandii*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Margined

Land Tortoise (*Testudo marginata*), South European, presented by Lord Arthur Russell, M.P.; an Indian Badger (*Arctonyx collaris*) from Assam, a Rough-billed Pelican (*Pelecanus trachy rhynchus*) from Mexico, purchased; two Red-crested Whistling Ducks (*Fuligula rufina*), a Variegated Sheldrake (*Tadorna variegata*), five Summer Ducks (*Aix sponsa*), five Chilian Pintails (*Dafila spinicauda*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

THE CONSTANT OF ABERRATION.—M. Otto Struve presented to the Imperial Academy of Sciences of St. Petersburg, in February last, a memoir by M. Nyren, of the Observatory at Pulkowa, on the aberration of the fixed stars. He states it is the result of researches made by M. Nyren during many years, with the view to determine the value of the constant of aberration, with the highest degree of accuracy which the most perfect means of observation allow. The value 20″·445, deduced by W. Struve, has been so far generally accepted by astronomers as the most exact, and has been employed in all astronomical calculations. This is the value given in his memoir upon the subject, but in 1852, by a new combination of his measures, the constant was altered to 20″·463, and with respect to this value he remarked: "Elle me paraît le vrai résultat pour l'aberration, qui doit être tiré de mes observations du premier vertical." (Preface to "Recueil de Mémoires présentés à l'Académie des Sciences par les Astronomes de Poulkova," t. i.) Notwithstanding this statement, Struve's first value was retained in our ephemerides, &c.; we have a suspicion that his correction, as he appears to have considered it, was very generally overlooked. M. Nyren was charged with the execution of a new series of observations at Pulkowa, with the same instrument employed by the elder Struve, and every endeavour was made to free the new series from all objection that it was possible to bring against the earlier one. Further, M. Nyren discussed a long series of excellent observations made by M. Wagner with the great meridian telescope in the years 1861–72, on the three stars, Polaris, δ Ursæ Minoris, and 51 (Hev.) Cephei. M. O. Struve remarks that with these two new determinations we now possess seven separate series of observations executed with the three great instruments of the Observatory of Pulkowa, and he gives the values of the constant of aberration resulting therefrom as follow:—

W. Struve, prime-vertical instrument	...	20″·463 ± 0″·017
Schweizer, meridian telescope	...	20·498 ± 0·012
Peters, vertical circle	...	20·507 ± 0·021
Gyldén, ,, ...	...	20·469 ± 0·026
Wagner, meridian telescope	...	20·483 ± 0·012
Nyren, vertical circle	...	20·495 ± 0·021
Nyren, prime-vertical instrument ...	...	20·517 ± 0·014

M. O. Struve considers that these values sufficiently prove that the constant of aberration is now known with a degree of accuracy which it will be difficult to surpass; it appears certain that the mean of the seven determinations deduced by M. Nyren, 20″·492, will not be liable to an error of a hundredth of a second.

If this mean value for the constant of aberration is combined with the velocity of light determined by M. Cornu and Mr. Michelson, the solar parallax is found to be 8″·784, which, M. Struve adds, only differs by a very few hundredths of a second from the most reliable determinations lately obtained by the geometrical process.

With regard to W. Struve's alteration of the constant of aberration assigned in his memoir, it may be remarked that his result depended upon observations made with the prime-vertical instrument upon seven stars, and the separate values accorded well. But, as he subsequently pointed out, this agreement of different determinations, obtained with the same instrument, only guaranteed the accuracy of the final result under the condition that there existed no common source of error. He examined all possible sources of constant error, and convinced himself that none existed which could exercise an appreciable influence. Nevertheless he said it must be admitted that there existed an agent which possibly might prejudice the exactness of his determination. Considering that the observations of the maximum of aberration fall at a time of year when the star passes the meridian near 6 p.m., while the observations of the minimum of the aberration take place at 6 a.m., it is seen that the first are made during a decreasing temperature and the last during an increasing one. "The zenith-distance of the star being determined from the time between the two corresponding transits indicated by the clock, it follows, if the clock has a defect of compensation and if its effective rate during the interval differs from the mean daily rate obtained by observations of consecutive days, that the error produced acts in the same sense upon the results obtained by different stars." It is the same if between the two corresponding passages the azimuth of the axis of rotation changes. Fortunately these two perturbing causes only exercise a minute influence upon the zenith distances to be determined. Yet, as Struve asks: "Comment prouver que cette influence n'ait point altéré la valeur trouvée de l'aberration de quelques centièmes de seconde?" He considered he had direct proof that there was no azimuthal change, but with regard to change of clock rate, as already stated, he was induced to rediscuss his series of observations with the result above given.

ON THE FUNCTION OF THE SOUND-POST, AND ON THE PROPORTIONAL THICKNESS OF THE STRINGS OF THE VIOLIN[1]

SIR JOHN HERSCHEL says: "It (the bridge) sets the wood of the upper face in a state of regular vibration, and this is communicated to the back through a peg set up in the middle of the fiddle and through its sides, called the 'soul' of the fiddle, or its sounding-post."[2]

Savart says: "L'âme a pour usage de transmettre au fond les vibrations de la table . . . son diamètre est déterminé par la qualité du son qu'on veut avoir; il est maigre quand elle est trop mince, et sourd quand elle est trop grosse."[3]

Daguin, in his "Traité de Physique," devotes a whole page to the discussion of the functions of the sound-post. The most important sentences are the following:—" . . . l'âme n'agit pas comme conducteur du son. . . Il nous semble que l'on doit expliquer l'effet de l'âme de la manière qui suit. L'âme, ou les pressions extérieures par lesquelles on la remplace, a pour effet de donner au pied du chevalet un point d'appui autour duquel il vibre en battant sur la table de son autre pied. Si l'un des pieds n'était appuyé sur un point fixe, il se releverait pendant que l'autre s'abaisserait, parceque les cordes n'agissent pas normalement à la table, puisque l archet les ébranle très obliquement, ce qui entraîne le chevalet dans un mouvement transversal quand il n'a pas de point d'appui fixe. Lorsque l'archet est dirigé normalement aux tables, cet inconvénient n'existe plus, et l'âme n'est plus nécessaire."[4]

Helmholtz says: "The vibrating strings of the violin, in the first place, agitate the bridge over which they are stretched. This stands on two feet over the most mobile part of the belly between the two '*f*' holes. One foot of the bridge rests upon a comparatively firm support, namely, the sound-post, which is a solid rod inserted between the two plates, back and belly, of the instrument. It is only the other leg which agitates the elastic wooden plates, and through them the included mass of air.[5]

The experiments[6] which follow have been made for the purpose of ascertaining whether it be any part of the function of the sound-post to convey vibrations to the back, or whether this post acts solely as a prop supporting the belly, so that its elasticity is not injured by the pressure from the strings, and also, as Daguin states, affords the firm basis which he considers necessary for one foot of the bridge.

Mr. Hill and other practical men maintain that the quality of the wood of which the sound-post is made affects the tone of the violin, as undoubtedly do very minute differences of position. If the quality of the wood is important, we must admit that vibrations are conveyed by the post.

Whether or not the sound-post exercises the function of transmitting vibrations, it is obvious (1) that it performs the important duty of contributing to the support of the belly; (2) that the nodal arrangement of the belly and also that of the back are

[1] Paper read at the Royal Society, May 24, by William Huggins, D.C.L., LL.D., F.R.S.

[2] "Encyclopædia Metropolitana," Article "Sound," p. 804.

[3] "Mémoire sur la Construction des Instruments à Cordes et à Archet," 8vo, Paris, 1819. Also Biot's "Report," *Ann. de Chimie*, tome 12, pp. 225-255.

[4] "Traité de Physique, Acoustique," tome 1, p. 575.

[5] "Sensations of Tone," translated by Ellis, p. 137. In the 4th German edition this passage remains unaltered.

[6] I wish to express my indebtedness to Mr. A. J. Ellis for some suggestions in connection with these experiments.

influenced by the pressure of the ends of the post against the upper and lower plates; (3) that Helmholtz is right, at least so far that the leg of the bridge under the fourth or G string has much more power than the other in setting the belly into vibration.

The usual way of investigating vibrations by the scattering of sand over the surface of the agitated body is difficult of application to the violin, on account of the curved form of the upper and lower plates. I found a convenient method to be by the use of what I may call a touch-rod. It consists of a small round stick of straight-grained deal a few inches long; the forefinger is placed on one end, and the other end is put lightly in contact with the vibrating surface. The finger soons becomes very sensitive to small differences of agitation transmitted by the rod.

The experiments were made on a strongly made modern violin, and in some cases repeated on a fine violin by Stradiuarius in the possession of the writer.

The sand method, and also the touch-rod, showed that the position of maximum vibration of the belly is close to the foot of the bridge under the fourth string. The place of least vibration is exactly over the top of the sound-post behind the other foot of the bridge. The back is strongly agitated, the vibrations being least powerfully felt where the sound-post rests, which is at nearly the thickest part of the back. These effects were very satisfactorily observed on a violoncello, where the phenomena are on a larger scale.

When the sound post was removed from the violin the large difference of the amount of vibration on the two sides of the belly was no longer present, the belly was about equally strongly agitated on both sides, making allowance for the string which was bowed. The tone became very poor and thin, as is well known to be the case when the sound-post is removed. The vibration of the back was now very feeble as compared with its vibration when the sound-post was present, a circumstance in favour of the view that the sound-post conveys vibrations to the back.

A clamp of wood was prepared which could be so placed on the violin as to connect by an arch of wood outside the violin the place of the belly behind the bridge where the top of the sound-post presses with the place of the back where it rests. It was expected that the wooden arch would restore to some extent the connection of belly and back which was broken by the removal of the post, and carry, though imperfectly, vibrations from the upper plate to the back.

When this clamp was put on, the poor and thin sound was altered to the fuller character of tone which belongs to the violin when the sound-post is in its place. On testing the condition of the back its normal state of vibration was found to be in a large degree restored. If, while the strings were being bowed, the clamp was suddenly removed, the tone at the same moment fell to its poor character, and the vibration of the back as instantly diminished.

It was further observed that, if the upper part of the clamp pressed upon the belly without the lower part coming into contact with the back, the tone is altered in the direction as when the sound-post was present, but it was not until the lower part of the clamp was in contact with the back that the normal character of the tone was fully restored. A similar effect to that resulting from the pressing of one end of the clamp only was produced by firmly placing one end of a wooden rod at this part of the belly. This effect may be due to the setting-up in the belly, by pressure at this part, of the peculiar nodal arrangement which the post produces when in its place.[1]

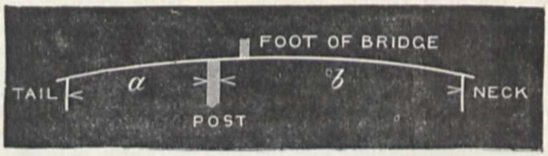
There could be no doubt that vibrations were carried by the clamp, for the lower end was powerfully agitated when the upper end rested upon the belly. If the sole function of the sound-post is to serve as a firm prop for the foot of the bridge, it should fulfil this condition most fully when placed under the foot of the bridge. In this position of the sound-post, however, as is well known, the tone is much injured.

In order to separate that part of the function of the sound-post which serves as a support from the further function it may possess as a transmitter of vibrations, it was desirable to introduce such alterations in the structure of the sound-post as would enable it to retain its supporting power, and yet greatly modify and, if possible, stop its power of transmitting vibrations. A sound-post was made in which about half an inch of the middle was cut out, and a piece of lead inserted, also a sound-post in which instead of lead sealing-wax was put in. The effect of these compound posts which retained uninjured their prop power was to modify greatly the quality of the tone, but not to diminish its quantity in any marked degree, a result in favour of the view that the character or the wood of which the post is made does influence the tone, and that vibration is transmitted by the post. As these compound posts could transmit vibrations freely, it was desirable to contrive a post which would not carry vibrations and yet form a firm prop. A post was made with a piece of hard indiarubber inserted in the middle, but this post was found by experiment with a tuning-fork to transmit vibrations to some extent. Other materials were tried without success. A post capped at each end with pieces of sheet vulcanised rubber stopped almost completely the sound of a tuning-fork when the foot of the fork rested on the rubber over one end of the post, while the other end equally protected with rubber rested on a body capable of reinforcing the sound of the fork. This rubber-capped post was firmly fixed in position in the violin, so that it would be able to support fairly well the belly and foot of the bridge, and yet not be able to carry vibration; unfortunately it does not seem possible, from the nature of things, to have a *rigid* prop which does not transmit vibrations, but this post, with thin sheet rubber at the ends firmly forced into position, must have been fairly efficient in its supporting power. The effect on the tone was about the same as when the sound-post was removed. When the wooden clamp was put on, then the normal tone returned, and the back vibrated strongly.

These experiments appear to show that the sound-post is more than a prop, and that, besides its other functions, it does transmit vibrations to the back in addition to those which are conveyed through the sides.

Experiments with sand and the touch-rod appear to me to show that Helmholtz's statement is too absolute when he says "it is only the other leg of the bridge which agitates the elastic wooden plates." Undoubtedly it is the fourth string foot of the bridge which is the more powerful in agitating the upper plate, but the other foot appears to me also to have an influence. When the post is placed exactly under the foot of the bridge, then the belly on this side is almost without vibration; if the post is absent, then this foot appears to agitate its own side of the belly as strongly as the other foot. As there is no post on the fourth string side of the fiddle, that foot stands in a position most favourable for setting up vibrations in the belly, being nearly half way between the supports of the belly at the tail and the

neck end of the violin. The other side of the belly, on the first or E string side, where the other foot of the bridge rests, is divided into two parts by the damping effect of the end of the sound-post, namely, the part *a* and the part *b*. It is obvious that



this foot of the bridge is unfavourably placed for setting the part of the belly, *b*, into vibration, since it is so far from its central mobile part. On the other hand, its position is favourable for a portion of its energy of vibration to be transmitted through the post to the back.

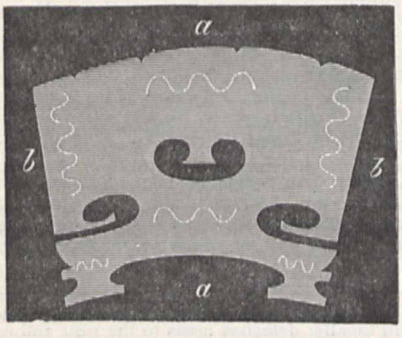
Practically very small differences of position of the top of the post behind the foot of the bridge are found to alter largely the character of the tone of the fiddle, and in the case of fine instruments the setting of the post is an operation demanding much care and judgment. The explanation lies probably in the circumstance that a small difference in the position of the post will

[1] According to Daguin some similar experiments were made by Savart, but I have failed to find them in those of his papers to which I have had access. "On peut la (l'âme) mettre en dehors, en l'appuyant à une espèce d'arcade dont on colle les pieds de chaque côté du violin. . . . On peut la remplacer par la pression d'un poids convenable appuyé sur la table supérieure." "Savart a conclu de là que l'âme a pour effet de rendre normales les vibrations de la table. . . ."—"Traité de Physique," tome i. p. 575.

alter greatly the proportion of energy passing through the post to that which is absorbed into vibrations of this side of the belly. At the same time it must also alter slightly the nodal arrangement of the belly, which must have an influence on the tone. If from the form of construction, or relative quality of the wood of the upper plate as compared with the under plate, the conditions of a violin are such that the highest quality of tone of which it is capable requires a relatively larger amplitude of vibration of the back, the position of the sound-post should be nearer the bridge. In a contrary condition of things the sound-post should be farther from the bridge. The extreme range needed in different violins is about a quarter of an inch. Any shift of the post must affect the relative mobility of the two sides of the belly.

If the sound-post transmits vibrations, these will be in addition to those received from the sides of the violin. It may be, therefore, that one condition which determines the best position of the post is the degree in which from their form and material these fulfil this duty. All the sides must share in this duty, but the touch-rod shows that a large part of this action is borne by the parts of the sides which curve inwards under where the strings are bowed. It is in harmony with this view that Mr. Hill states that if the inside blocks at the corners, which are put to strengthen these parts, extend in a small degree into these curved portions, the tone is injured.

The plane of the vibrations of the strings is that in which they are bowed, which is more or less oblique to the bridge. The vibrations may be considered divided into two sets at right angles to each other, *a* and *b*.



The touch-rod shows that these vibrations exist strongly in the upper part of the bridge. I venture to suggest that the use of the peculiar cutting of the bridge, which was finally fixed from trials, by Stradiuarius, is to sift the vibrations communicated by the strings and to allow those only or mainly to pass to the feet which would be efficient in setting the body of the instrument into vibration, the other vibrations which would be injurious in tending to give a transverse rocking motion to the bridge, being for the most part absorbed by the greater elasticity given to the upper part of the bridge by the cutting. Below the two large lateral cuts, the touch-rod shows a very great falling off of the vibrations *b*. In the case of a violoncello these vibrations were also very greatly reduced below the side openings of the bridge.

The violin on which the experiments were made was without a bass bar, which is a piece of pine glued to the under side of the belly on the fourth string side. This bar is regarded as strengthening the belly and also enabling it to respond better to the lower notes. The touch-rod showed no difference in the general behaviour of this violin from a fine one by Stradiuarius containing a bass bar.[1]

On the Proportional Thickness of the Strings.—As the lengths of the strings are the same, we have only the two conditions of weight and tension on which their pitch depends. It is obvious that for equal pressure on the feet of the bridge, as well as for more convenient fingering and bowing, the strings should be at the same tension. They should therefore differ in weight, so as to give fifths when brought to the same tension. The weights of the strings are inversely as the squares of the number of vibrations, which in the case of fifths is as 3 to 2, namely, as 9 to 4. As the first three strings are of the same material, it is more convenient to take their diameters, which must be as 3 to 2, that is, each string in advancing from the first string must be half as thick again as the string next to it. In the case of the fourth string, covered with wire, we must find the weight of the third string of gut, and take a fourth string of which the weight is 9 to 4 for the third string.

A good average thickness of 2nd (A) string = 0·0355 inch.
Then the strings should be— 1st = 0·0237 ,,
2nd = 0·0355 ,,
3rd = 0·0532 ,,

A gut string 0·0532 inch in diameter weighs, when of the same length as a fourth string, 0·98 grm., then the fourth = 2·20 grms.

Ruffini sells sets of strings in sealed boxes, and these were found to be in about the same relative proportion to each other as the sizes indicated on the gauges sold by several makers.

The measures of a set of Ruffini's strings were found to be:—

1st = 0·0265 inch.
2nd = 0·0355 ,,
3rd = 0·0460 ,,
4th = 1·4100 grm.

It will be seen that the first string is thicker, and the third thinner, and the fourth much lighter than the theoretical values. Therefore the tension of the first string would be greater, and that of the third and fourth strings less than they should be in relation to that of the second string. The greater flexural rigidity of the fourth string will have a small effect in the direction of making the vibrations quicker, and therefore of making the tension required less.

By means of a mechanical contrivance I found the weights necessary to deflect the strings to the same amount when the violin was in tune. The results agreed with the tensions which the sizes of the strings showed they would require to give fifths.

A violin strung with strings of the theoretical size was very unsatisfactory in tone.

The explanation of this departure of the sizes of the strings which long experience has shown to be practically most suitable, from the values they should have from theory, lies probably in the circumstance that the height of the bridge is different for the different strings. It is obvious, where the bridge is high, there is a greater downward pressure. By this modification of the sizes of the strings there is not the greater pressure on the fourth string side of the bridge which would otherwise be the case. On the contrary, the pressure is less, which may assist the setting of the belly into vibration. There is also the circumstance that the strings which go over a high part of the bridge stand farther from the finger-board, and have therefore to be pressed through a greater distance, which would require more force than is required for the other strings, if the tension were not less.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The next examination for Minor Scholarships and Open Exhibitions at St. John's College will take place in December, 1883. There will be open for competition, besides certain Exhibitions, two Minor Scholarships of 50*l.* per annum and two of 75*l.*; also such Foundation Scholarships as shall be vacant, two of which may, after the commencement of residence, be increased in value to 100*l.* each.

Candidates may offer themselves for examination in any of the following subjects:—Classics, Mathematics, Natural Science, Hebrew, or Sanskrit.

The Examinations will begin on Tuesday, December 11.

Successful candidates will be required to commence residence not later than October, 1884. Further particulars of the Scholarships and Exhibitions may be obtained in October, 1883, on application to one of the tutors.

SCIENTIFIC SERIALS

Bulletins de la Société d'Anthropologie de Paris, tom. v. fasc. iv. 1882.—Discussion on M. Ball's case of cretinism, in which the axiom advanced by M. Lunier was generally accepted, that, while idiocy

[1] In the "Early History of the Violin Family," Engel, speaking of the Crwth, says:—"Furthermore, the contrivance of placing one foot of the bridge through the sound-hole, in order to cause the pressure of the strings to be resisted by the back of the instrument, instead of by the belly, is not so extraordinary and peculiar to the Crwth as most writers on Welsh music maintain. It may be seen on certain Oriental instruments of the fiddle kind which are not provided with a sound-post. For instance, the bridge is thus placed on the three-stringed fiddle of the modern Greek, which is only a variety of the ordinary rabâb, but which the Greeks call lyra. Inappropriate as the latter designation may appear, it is suggestive, inasmuch as it points to the ancient lyra as the progenitor of the fiddle."—P. 28.

is hereditary and congenital, cretinism is endemic.—M. Gustave Le Bon, in defending the accuracy of his determinations of the comparative weight of the brain of boys and girls against the charges advanced by MM. Budin and Manouvrier, explains his methods of determination, which, in his opinion, confirm the conclusions contained in his earliest memoir on the subject: viz. that (1) while male and female children differ very little in weight at their birth, when, if the weight of boys be taken at 100, that of girls will be 94·28, the difference between the sexes in adult life may be at least three times greater; (2) that at the same age, with equal stature and weight, the female brain will be found notably inferior in weight to that of the man.—On the cranial dimensions of the savage Stiengs, or Moïs, of Cochin China, by Dr. P. Neis, who finds that this people exhibits the low mean cranial capacity of 1400, with a cephalic index of only about 75.—M. Capitan records the results of his experiments on the methods of trepanning employed in prehistoric times. He has experimented both on the living and dead subject, using a flint instrument, with which he reproduced perforations similar to those observed in prehistoric crania. This was effected by boring and incision, as well as by scraping, and in both cases the animals operated on recovered rapidly and completely from the operation, although Broca had maintained that the removal of any part of the cranial surface could not possibly have been effected on the living subject by such instruments as were used by primitive man.—Dr. Collignon describes the nature of the human remains found at Cumières, Meuse, belonging to the Neolithic age, among which are seven well preserved skulls, and various long bones, including two platycnemic tibiæ.—Dr. Heurot's report of the ossuary of the polished stone period, discovered in 1881 at Liry, in the Ardennes, was laid before the Society by M. Mortillet, who drew attention to the extraordinary projection of the lower jaw observable in one of the crania, which in this particular seems to foreshadow the present and future evolutionary change, rather than to accord with the ordinary type of the receding anthropoidal chin of the prehistoric ages. In the course of the discussion arising out of Dr. Heurot's communication, M. Legnay described similar burial places examined by himself at Le Grand Compant, near Luzarches, and at Vaureal, Pontoise, where, as at Liry, a passage composed of upright stones, and covered in with wood, gave admittance to the true sepulchral chambers.—M. Topinard reports on his examination of *Le Questionnaire de Sociologie et d'Ethnographie*, issued by the commission appointed by the Society for its elaboration; and while he approves generally of the plan followed, which is that suggested by M. Letourneau, he has drawn attention to numerous points omitted by the latter, who, by his mode of defending the proceedings of the Society, and attacking M. Dally, gave an aggressively personal character to the discussion, very unusual in meetings of the Society. Owing to want of unanimity among the members, the method to be followed for the French system of instructions for travellers still remains undecided.—The Galibis of Cayenne, who have long been established in the Jardin d'Acclimatation of Paris have been made the subject of an exhaustive study by M. Manouvrier, whose detailed communications of the numerous observations and determinations in regard to the sociology, language, and ethnology of these tribes led to a somewhat lengthy discussion on the *rationale* and early extension of the practice of the *couvade*, which has been observed among the Galibis of French Guiana, as well as among the Basques, and appears to have prevailed under various modifications among several ancient peoples.

Rendiconti of the *Reale Istituto Lombardo*, May 31.—A comparative study of the fauna of the various Pliocene deposits in Lombardy, by Dr. C. F. Parona. As many as 275 species were examined, 248 in the Pliocene of the Northern Apennines, and 187 in the Upper Miocene, of which 117 still survive in the neighbouring seas.—On Paff's method of integration of partial differential equations of the first order, by Prof. E. Beltrami.—A contribution to the history of the adulteration of food from the earliest times, by C. L. Gabba.—On the mortality of infants during the first and second years of their lives in the various provinces of Italy, by Prof. G. Sormani. For the decade ending 1880 the average rate of mortality in the first year throughout Italy was 214·9 per 1000, and in the second 114·6 per 1000. Compared with the rest of Europe, these figures show that Italy occupies the lowest position in the scale, the death-rate being in excess even of Croatia and Slavonia (107·4) and of Russia (102·7). In the general comparative table, Ireland stands first (34·5), England occupying a medium position with an average of 59·1 per 1000.—The career of David Lazzeretti, founder of the new sect of Lazzerettists, studied in the light of documents recently discovered, by G. Barzellotti.—The telephone in its legal aspect (continued), by C. Norsa.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale, June, 1883.—Report on M. Lavanchy-Clarke's workshops for the blind, by M. Legentil.—Report on M. Latry's tinted papers, by M. Ern. Dumas.—Colouring elements of madder and their metamorphoses, by M. A. Rosenstiehl.—On the saline tracts in the south-east of France, by M. P. de Gasparin.—On sewing-machines and sewing-machine industries of all sorts, as shown at the Paris Universal Exhibition of 1878, by M. Emile Bariquand.

THE number for June 15 of the *Archives des Sciences Physiques et Naturelles* contains researches on the absorption of ultra-violet rays by different substances (seven plates), by M. J. L. Soret (fourth memoir).—A new contribution concerning the family of Tintinodea, by Dr. Herman Fol (one plate).—On the magnifying power and strength of dioptric arrangements, by Dr. Adrien Guébhard.—Meteorological observations at the Geneva Observatory for the month of May.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, June 6.—Mr. J. W. Hulke, F.R.S., president, in the chair.—George Paul was elected a Fellow of the Society.—The following communications were read:—The estuaries of the Severn and its tributaries, an inquiry into the nature and origin of their tidal sediment and alluvial flats, by Prof. W. J. Sollas, M.A., F.R.S.E., F.G.S.—Notes on a collection of fossils and rock-specimens from West Australia, north of the Gascoyne River, by W. H. Hudleston, M.A., F.G.S.—Notes on the geology of the Troad, by J. S. Diller. Communicated by W. Topley, F.G.S. This paper gave a brief account of the results obtained by the author whilst attached to the United States Assos Expedition. Together with a geological map (scale 1 : 100,000) this was sent to Mr. Topley for the service of the new geological map of Europe (and its borders), which is now being prepared by a Committee of the International Geological Congress. The country described is that lying south and west of the River Menderé (Scamander). The sedimentary rocks may be divided into three great groups:—1. An old, possibly Archæan, highly crystalline series, forming the mountainous lands of the Ida range (5750 feet), but also appearing in smaller detached areas to the west and north-west. Probably these have existed as islands from early times, and around these the later rocks have accumulated. Mount Ida itself is almost a dome, the lowest rocks (talc schists) occupying the summit. On the northern slopes there is true gneiss. No igneous rocks enter into the structure of this mountain. At different horizons there are bands of coarsely crystalline limestone, and as far as can be seen this series is conformable throughout. 2. Resting on these old rocks and in part made up of their remains is a series of partially crystalline rocks, chiefly limestone. It is probable that this series is in large part of Cretaceous age; but it contains rocks which are older, possibly Palæozoic. Eocene fossils have lately been discovered by Mr. Frank Calvert, which also may have come from this series. The rocks in the south of the Troad, hitherto supposed to be Lower Tertiary, are now known to be of later date. Sharply marked off from these older rocks are the Upper Tertiaries; these are of two ages, occurring in two distinct areas. 3. The *Upper Miocene*, which fringes the western shores of the Troad, and forms a broader band at the north-west corner in the lower course of the Menderé. Hissarlik is built on this. These beds are marine, and belong to the *Sarmatian Stage*. The Troad is the most south-westerly point at which the *Mactra-kalk* is yet known. 4. Freshwater beds, which occur in force in the interior of the country, between the Menderé and the south coast, and in patches near the coast. These are *Upper Miocene* or *Lowest Pliocene*. Later than these are the *Pliocene beds* of the great plain of Edsemet. The igneous rocks are of various ages, but most are of Tertiary date. The oldest is a *granite* which intrudes through and alters the oldest (? Archæan) crystalline rocks. This is invaded by dykes of *Quartz-porphyry*. *Quartz-diorite* invades and alters the group of partially crystalline rocks. The oldest rocks in the newer series are the *Andesites* and *Liparites*. These, in part, are older than the Sarmatian stage, as the conglomerate at its base contains fragments of these rocks. But they are also in part of later date. Where they can be studied together the Liparite is the later of the two, as it flows through and carries up fragments of the Andesite. The Andesite (unlike the Liparite) seems to have reached the surface, in some cases, through volcanic vents. *Basalts* and *Nepheline-basalts* are of late Tertiary date; possibly they are the latest volcanic rocks of the district, but their relation to the other eruptive rocks of the Troad cannot be definitely determined. The volcanic rocks in the isolated area between Alimadja and Lyalar are interesting because their relative ages are here well seen. The earliest was melaphyre; this was followed by mica-andesite, horneblende-andesite, augite-andesite, basalt, and late (if not last) by liparite. Mr. Topley, who in the absence of the author read the paper, explained the objects of the Assos Expedition and the geological results obtained by Mr. Diller. He gave a short account of previous literature, and mentioned some of the main points in which our knowledge of the Troad is now advanced. Mr. Topley briefly described the physical geography and general structure of the country, illustrating this by means of a section which he had prepared from Mr. Diller's map and paper.

Zoological Society, June 19.—Prof. Flower, F.R.S., president, in the chair.—The Secretary read an extract from a letter received from Mr. Albert A. C. Le Souëf, containing observations on the colouration of the plumage of the Satin Bower-bird (*Ptilonorhynchus holosericeus*).—Prof. E. Ray Lankester, F.R.S., read a memoir on the muscular and endoskeletal systems of *Limulus* and *Scorpio*, drawn up by himself with the assistance of his two pupils, Mr. W. J. Barham and Miss E. M. Beck. These investigations seemed to confirm Prof. Lankester's previously expressed views as to the near affinity of these two forms, hitherto usually referred to different classes of the animal kingdom, and to justify the association of *Limulus* with the Arachnida.—A paper was read by Dr. Gwyn Jeffreys, F.R.S., F.Z.S., on the Mollusca procured during the cruise of H.M.S. *Triton* between the Hebrides and Faroes in 1882. Ten new species of Gastropoda were described, and another species (*Fusus sabini*) was fully diagnosed. The chief interest of the paper consisted in the distinction of the Mollusca inhabiting the "warm" and "cold" areas of that sea-bed, in accordance with the views of Dr. Carpenter and the late Sir Wyville Thomson.—A communication was read from Mr. Martin Jacobi, containing descriptions of some new species of Beetles belonging to the family Galerucidæ.—Prof. P. Martin Duncan, F.R.S., read a paper on the Madreporarian genus *Phymastræa* of Milne-Edwards and Jules Haime, and gave the description of a new species obtained on the west coast of India, which he proposed to call *Phymastræa irregularis*.—Dr. J. S. Garson, F.Z.S., read a paper on the anatomy of the Pygmy Hog of Nepaul (*Porcula salvania* of Hodgson), as exhibited in a female specimen of this animal which had lately died in the Society's Gardens. Dr. Garson came to the conclusion that this animal was not sufficiently different from the true Pigs (*Sus*) to warrant its generic separation.—A communication was read from Mr. Osbert Salvin, F.R.S., containing an account of a series of birds collected by Capt. A. H. Markham, R.N., at various points of the western shores of the Pacific, from Esquimault on the north, to the Straits of Magellan on the south, including some from the Galapagos Islands and from the island of Juan Fernandez.—Mr. E. W. White, F.Z.S., read some notes on the birds of the Argentine Republic, being a supplement to two former papers read before the Society on the same subject.—A communication was read from Mr. A. Boucard, C.M.Z.S., containing an account of a collection of birds made in Yucatan by Mr. Gaumer.

Sydney

Royal Society of New South Wales, May 2.—Annual meeting.—The number of new members elected during the year was forty-one, making the total number of ordinary members upon the roll to date 486. At the Council meeting held on December 13 it was unanimously resolved to award the Clarke Memorial Medal for the year 1883 to Baron Ferdinand von Müller, K.C.M.G., F.R.S., Government Botanist, Melbourne; and at the same meeting the Council awarded the prize of 25*l*., which had been offered for the best communication on the "Influence of Australian Climates and Pastures upon the Growth of Wool," to Dr. Ross, M.L.A., Molong; and the prize for the one upon "The Aborigines of New South Wales" to Mr. John Fraser, B.A., West Maitland. During the year the Society held ten meetings, at which the following papers were read:—Annual address by H. C. Russell, F.R.A.S.—On the geology of the Hawkesbury sandstone, by Rev. J. E. Tenison-Woods, F.G.S.—On tropical rains, by H. C. Russell, F.R.A.S.—On the orbit of the late comet, by G. Butterfield.—On a method of determining the true south, by J. S. Chard.—Notes on the progress of New South Wales during the years 1872 to 1881, by Christopher Rolleston, C.M.G.—On some marine fossils of the coal-formation of New South Wales, by Rev. J. E. Tenison-Woods, F.G.S., F.L.S.—On some Mesozoic fossils from the Palmer River, Queensland, by Rev. J. E. Tenison-Woods, F.G.S., F.L.S.—On French geographical societies and the colonies, by E. M. de la Meslee.—Notes on the aborigines of New Holland, by James Manning.—On the ashes of some Epiphytic ferns, by W. A. Dixon, F.C.S.—On a fossil plant formation in Central Queensland, by Rev. J. E. Tenison-Woods, F.G.S., F.L.S.—The Medical and Microscopical Sections held regular monthly meetings. The sum expended upon the library during the year was 422*l*. 12*s*. 10*d*. At the annual meeting M. Louis Pasteur, M.D., was unanimously elected an Honorary Member of the Society, to fill the vacancy caused by the death of the late Dr. Charles Darwin, M.A., F.R.S., and Dr. Ottokar Feistmantel of Calcutta was elected a Corresponding Member.—Names of the new Council:—President, Hon. J. Smith, C.M.G. Vice-Presidents: Charles Moore, F.L.S., W. A. Dixon, F.C.S. Hon. Treasurer, H. G. A. Wright, M.R.C.S.E. Hon. Secretaries: Prof. Liversidge, F.R.S., F.G.S., Dr. Leibius, F.C.S. Members of Council: Robert Hunt, F.G.S., Dr. W. Morris, P. R. Pedley, Frederick Poolman, Chr. Rolleston, C.M.G., H. C. Russell, F.R.A.S.

Paris

Academy of Sciences, July 2.—M. Blanchard, president, in the chair.—Obituary notices of M. Maillard de la Gournerie, by M. Bertrand; of Mr. William Spottiswoode, by M. Dumas; and of General Sabine, by M. d'Abbadie.—On the condensation and liquefaction of gases, by M. J. Jamin.—On the tornadoes that swept over Kansas, United States, on May 30, 1879, by M. Faye. Although every tornado almost invariably takes place in the south-west quadrant of an area of comparatively low pressure (Finlay's "Report of 600 Tornadoes"), this meteorological condition is not to be regarded as their true cause. The author shows on the contrary that, like other storms and hurricanes, they are due to whirlwinds descending with vertical axis, and originating, not in the lower atmospheric strata, but in the upper currents whose direction is entirely independent of the light winds previously prevailing near the surface of the earth.—Remarks and observations on MM. Carl Vogt and Emile Yung's treatise on practical comparative anatomy, by M. de Quatrefages. For Darwin's biological tree representing all life past, present, and even future on the globe, Vogt and Yung substitute a grove composed of many distinct trees, the number and species of which still remain to be determined. But while this conception deprives the Darwinian theory of much of its seductive grandeur, evolution itself can lose nothing by abandoning an absolute system in which mere hypothesis plays far too large a part.—On a complete system of the combinations of two biquadratic binary forms, by M. C. Stephanos.—On a class of lineal equations of the fourth order, by M. E. Goursat.—On surfaces of the third order, by M. C. Le Page. A method is proposed of constructing a surface of the third order determined by nineteen points.—On the application of Ampère's method to the determination of the elementary law of electrical induction by displacement, by M. Quet.—Electrodynamic actions involving arbitrary functions; hypotheses determining these functions, by M. P. Le Cordier.—Method of unmagnetising timepieces which have become magnetised by the vicinity of a powerful magnetic field, by M. Deprez.—Action of chlorhydric acid on the protosulphuret of tin, by M. A. Ditte.—On the fusibility of salts, by M. E. Maumené.—On a new process of making a quantitative analysis of urea, by M. L. Hungounenq.—An examination of the corpuscles held in suspension in water, by M. Eug. Marchand.—Deposits of barytine, celestine, and anhydrite, their association and probable mode of formation, by M. Dieulafait. The experiences of M. Gorgeu are shown to be inadequate to explain the formation of these substances in lodes and in saline lands. At the same time they are not to be absolutely rejected, and may prove to be of great value when the chemical aspect of volcanic phenomena is taken seriously in hand.—Influence exercised by the elements contained in sea water on the development of fresh-water animals, by M. H. de Varigny. From experiments made with the spawn of frogs and other organisms, it appears that chloride of sodium (kitchen salt) is the substance most noxious to the development of fresh-water animals.—Application of heat to the preservation of wines in common use, the blends known as "vins de coupage," by M. E. Houdart. By this process all danger of fermentation is avoided, while the quality and appearance of the wines so treated remain unimpaired.

BERLIN

Physiological Society, June 15.—In continuation of the experiments upon the influence of temperature upon the time occupied by reflex actions, which Prof. Kronecker described at the last meeting, Prof. Ewald communicated observations which he had made upon patients who were suffering from rabies. These patients responded with a reflex jerk quicker in a temperature between 0° C. and 5° C. than in temperatures between 40°—50°, and at higher temperatures the times occupied by a reflex action again became shorter.—Dr. B. Baginsky spoke about the results of experiments which he had instituted in order to determine the function of the cochlea. It is well known that anatomical research has determined that the membrana basilaris of the cochlea, in which the terminal filaments of the auditory nerve are distributed, increases in breadth from the bottom towards the upper part; and Herr von Helmholtz had founded an hypothesis upon this to explain the differentiating perception of certain higher tones, viz. that the sound-waves that penetrate into the cochlea occasion a synchronous vibration either in the broader upper half or in the narrower lower half of the membrana basilaris, so that the higher tones would excite the fibres of the auditory nerve distributed in the lower part, and the deeper notes the fibres distributed in the upper part. In animals which are low in the scale of development there is a similar arrangement, which consists of auditory cilia of different lengths, which have the same function, as the shorter ones are intended for the higher notes, and the longer ones for the deeper notes and noises, and are set into synchronous vibration by them. This hypothesis has been experimentally confirmed in the case of the auditory cilia of the lower animals, and it had actually turned out true that deep notes produced vibrations in the long hairs, and high notes in the short ones. Herr Baginsky now undertook to test the hypothesis of Herr von Helmholtz experimentally on the cochlea of higher animals. After he had succeeded in overcoming the great practical difficulties, he wounded the top of the cochlea of the healthy ear in dogs which had been made absolutely deaf of their other ear, and then observed their hearing powers by means of the different notes of organ-pipes between *c* and *c''''*. On the third day after the immediate consequences of the operative interference had disappeared, it was found that the dogs responded perfectly to the notes *c''''*, *c'''*, *c'''*, *c''*, but were deaf to the deeper notes. This condition remained unaltered for weeks, and when the animal that had been the subject of experiment was killed, the post-mortem examination showed that the top only of the cochlea had been wounded, and that the filaments of the auditory nerve that were distributed to that portion were destroyed. Less precise were the results of the experiments in which the lower part of the cochlea was destroyed; in these cases absolute deafness occurred in a succession of cases; in other cases, again, the dogs responded to high as well as to low notes, to the latter, perhaps, a little better; and again, in other cases, on the other hand, the dogs only responded to the notes *c*, *c'*, *c''*, while they were deaf to the higher notes. But this condition only lasted some fourteen days; then hearing power for the higher notes set in again, and soon reached the same sensitiveness as that for the deep notes. Post-mortem examination showed in these various cases different degrees of distinction occasioned by the operation. Herr Baginsky believes that he has by his experiments, in particular by the results of lesion of the top of the cochlea, verified experimentally for the mammalian cochlea the hypothesis of von Helmholtz.—Dr. B. Fränkel spoke concerning the different views of authors as to the behaviour of the pharyngo-nasal isthmus during the phonation of vowels, and about the attempts which have been made, up to the present inconclusive, to prove the closure or the patency of the isthmus. He himself has become convinced by his observations that in the phonation of all vowels the communication between the pharynx and nasal cavity remains patent, although more or less narrowed, and he demonstrated this partly by means of a spirit-manometer, one of whose limbs was brought into connection with one nostril, at the same time closing the other nostril while he was sounding the letter, or by means of a flame towards which he directed an elastic tube which was in connection with both nostrils. Not only on pronouncing A, but also with E, O, I, and U, a current of air was seen to issue from the nose. Dr. Fränkel then discussed the various varieties of nasal speech, of which he distinguishes three anatomical varieties, and finally gave his view as to the function of the uvula, which occurs only in man and in some of the higher apes, viz. that it has got nothing to do with the shutting off the isthmus nasopharyngeus or any connection at all with speech; it serves rather to protect the larynx in swallowing by dividing mouthfuls of solid food and drink into two portions, and thus compelling them to slip down on either side of the larynx; it likewise forms an elongation of the epiglottis.—Prof. Kronecker gave a short exposition of a demonstration which Dr. Openschewsky gave to the Society. In experimenting on the influence of the vagus and upon the gastric movements, it was observed that when the peripheral end of the gastric branch of the vagus is stimulated by single currents, the contraction of the cardia does not occur until after the cessation of the stimulations, although during the continuance of these no contraction of the stomach is observed, when a certain frequency of repetition of the stimuli has been attained. This induced Dr. Openschewsky to examine more closely the inhibitory action of the vagus. It has now been known for a good many years that in high degrees of anæmia the cardia executes spontaneous rhythmical contractions; by ligature of the coronary artery this anæmia could be artificially produced and the rhythmical contractions could be produced in the cardia. If the peripheral ends of the gastric branches of the vagus were now stimulated, an inhibition of these movements of the cardia regularly occurred, which lasted as long as the stimulation of the vagus. It is thus proved that the gastric branches of the vagus contain inhibitory as well as excitant fibres, exactly as its cardiac branches; and Dr. Openschewsky proposes to work out this part of the physiology of the vagus still further.

VIENNA

Imperial Academy of Sciences, April 12.—M. Abeles, on secretion from the living kidney if floated through with blood.—E. Hussak, on cordierite in volcanic outcasts.—E. Zuckerkandl, on the communications between the arteries of the human lung.—J. Wroblewski and K. Olszewski, on the liquefaction of oxygen and solidification of carbon disulphide and alcohol.—G. Goldschmidt, on pyrene-quinone.—T. von Oppolzer, tables to determine eclipses of the moon.—J. Liznar, a note on the theory of Lamart's variation apparatus for horizontal intensity.

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