THURSDAY, NOVEMBER 18, 1875

MR. GLADSTONE AT GREENWICH

WE may surely regard it as a hopeful sign of progress that a whole page of the *Times*, as well as of other daily papers, of last Friday was practically devoted to the discussion of matters connected with Science and Art. When we find the daily papers giving so great prominence to these subjects, and when men of such position and mark as Prince Leopold, Mr. Gladstone, and the Lord Chief Justice, take what is evidently a genuine interest in the progress of science and art education among the lower classes, it seems quite safe to infer that this movement has at last taken a prominent and important place in the everyday life of the country.

Prince Leopold, in his address at Oxford, showed that he had taken some pains to become acquainted with the latest statistics of the Science and Art classes. The discrepancy between Prince Leopold's statistics and, those of Mr. Gladstone has been commented upon in the *Times*. It would appear from an examination of the last Report of the Science and Art Department, however, that the figures which Prince Leopold gives for the number of students under instruction in science are probably the *number of papers worked* at the last May examinations. This, possibly, is an error in reporting. Mr. Gladstone, on the other hand, gives the right number—"about 48,000"—of the students under instruction *last January*; a different number, of course, to that in May 1874, when it was 53,050, or in May 1875, which has not yet been published, as far as we are aware. But in some way he has arrived at, or been furnished with, a wrong total for the number of Art students. This should be 54,800 odd, irrespective of the scholars in Elementary Day Schools. At the same time it is gratifying that a man like Mr. Gladstone should think it worth his while to take an interest in the matter at all, but when he does determine to think about it, the least he can do is to inform himself correctly as to statistics.

Mr. Gladstone set himself almost entirely to impress upon his audience the value of an education in the principles and practice of art; he attempted to show that really artistic handiwork had not only a refining, elevating influence even on the workman himself, but that it answered the requirement of utility in the best sense of the term. To his advocacy of the introduction of artistic taste into the commonest manufactures we can have no possible objection, but we distinctly demur to the ground on which he seems to have based the prominence that he gave it in his address. He found—wrongly, it appears—from the statistics that the proportion of students attending the Science classes was considerably larger than that of those who are attending the Art classes. According to the latest statistics this excess of Science over Art students is shown not to exist, and the inference that Science is getting more than its due share of attention, and that the claims of Art require special advocacy as being neglected, seems to us unwarranted on several grounds. The truth is the Art classes were established for many years before the Science classes, and the fact that there has been such a rush upon the latter simply proves that they meet a wider and deeper want than do the former; that, in short, the nation feels that it stands more urgently in need of science at present than of art.

We infer, moreover, from what Mr. Gladstone said, that he thinks the practical application of science ought to be endowed in preference to abstract scientific investigation and education in scientific principles. But is it not much more rational and really practical that the men who are getting their education at these Science and Art classes should be educated in the main principles and leading facts of science before they are taught how to apply them? How is the best work likely to be got out of a man? Is it by teaching him the practice of a few traditional rules, incapable of expansion, and which have no meaning for him; or by educating him thoroughly in the scientific principles and data on which his handicraft is founded, and then leaving him to learn in the workshop how these are applied in practice? One might as well expect a carpenter to make a workman-like chair or table before he has learned to use the plane or saw, as expect the best work to be produced by the former course. The principles or laws of science are comparatively few; their applications are endless.

The student who has an accurate knowledge of principles will readily understand the applications. One school will, as it were, fit him out with all that is necessary for all industrial progress. To teach the applied sciences on the other hand requires a special school for all the various possible permutations and combinations that may be rung on the general principles.

By looking to general science, again, the Government avoids the difficulties which must necessarily accompany, with all the fluctuations of trade, any attempt to teach applied science except in some very general forms. The fact is that the practical applications of science bring their own reward, and need no extraneous encouragement; instruction and invention in them may very well and without the least hardship be left to those whose pockets they fill. Art receives ample encouragement, and is well rewarded by the nation; let but an artist in any department show himself capable of producing good work, and he will soon find that both the Government and private individuals have plenty of rewards to bestow upon him. Science, on the other hand, receives not a penny in the way of assistance or reward, and yet the scientific investigator is the nation's servant and greatest benefactor. Pure scientific research is at present, like virtue, its own reward; the man who devotes himself to such research, unless he has some other means of gaining a livelihood, is likely enough to starve for all the help he will get from his country; and yet, as it has been shown over and over again, our country's prosperity, the progress of nearly all our industries, and even the very existence of many of them, are dependent on the discoveries of the scientific investigator who pursues his research on purely scientific principles, and with no practical end whatever in view. Our country has got at least as much glory, and we venture to think more practical benefit, from achievements in the region of pure science, as from all that has been accomplished in the domain of art, and yet no helping hand is held out to those who are able and willing to do their country the highest service, but cannot, because they must drudge for a living. The domain of science is every day becoming more and more extended, her methods are becoming more and more complicated, and her instruments more and more expensive; in almost every department paths are being opened up which, if pursued to their end, would certainly lead to discoveries of vital importance to the best welfare and prosperity of the nation. Our public men are continually telling us that we are being outstripped by continental nations in fields which used to be peculiarly our own, and that simply because abroad every encouragement is given to scientific research, while here its existence is either ignored or it is regarded as a mere pastime. We can only think that Mr. Gladstone must have been imperfectly informed, or that he felt himself bound for the occasion to assume the position of special pleader on behalf of Art, which really can take very good care of herself.

We are grateful, however, for the unmistakable manner in which he referred to the City Companies. He put the case exactly as it ought to be put, and did not in the least exaggerate the crying scandal. Their pharisaical trumpeting of the pittances they dole out in the way of charity blinds very few, we should think, to the disgraceful way in which they discharge the stewardship of the enormous funds committed to their trust. What are these eleemosynary pittances compared to the sums they lavish yearly on their ponderous entertainments, relics of long past generations, when men were some stages nearer the lower animals than they are now, but which are now meaningless and out of date? These Corporations, though there are some wide-awake, practical, and, we must believe, advanced and cultivated men among them, seem to be quite unconscious of their lethargic, antiquated, and even dangerous position. We say "dangerous," for it is high time they should know that if they do not wake up out of their lethargy, and set their own house in order, they must very soon be wakened by a shock from without. The country cannot much longer forbear calling them to give an account of their valuable stewardship, and a sorry account, we fear they must render. It cannot be tolerated that while the advancement of the highest interests of the country is most seriously crippled for want of necessary means, those funds which were left by our benevolent predecessors in trust for the country's good, should rust in a useless napkin or be drawn upon only for the sensual gratification of those who foolishly fancy themselves their irresponsible trustees.

CHAMBERS'S ENCYCLOPÆDIA

Chambers's Encyclopædia, a Dictionary of Useful Knowledge for the People. Illustrated with Maps and numerous Wood Engravings. Revised Edition. Ten vols. (Edinburgh and London: W. and R. Chambers, 1874.)

WHEN the history of the English people during the present century comes to be written by some future Green—or it may be by the present one—the name of the publishing firm of W. and R. Chambers must be referred to with honour as having had a considerable share in fostering the great intellectual awakening among the people which was initiated in the earlier part of the century. By means of their *Journal*, which still maintains an honourable place among popular serials, their *Information*, their *Miscellany*, and other similar publications, they supplied the growing appetite of the people for useful knowledge with healthy and invigorating food, which at the same time stimulated a craving for more. We believe that in this way the Messrs. Chambers have done much to create the general want among the middle and lower classes which is now being gradually supplied by more organised and systematic means of instruction and culture. They were also among the first, if not the first, to publish for the use of schools a carefully compiled and almost complete series of text-books of science, a series which held its place for a long time, though no doubt now somewhat out of date, if not largely out of print. The crowning effort of this firm to provide "the people" with the means of obtaining useful and accurate information is no doubt to be seen in the "Encyclopædia" which they have brought out under the editorial care of Dr. Andrew Findlater.

Previous to the publication of this "Encyclopædia," which began to be issued in 1860, and to go no farther back than the present century, a large number of books of reference of this class had been published both in England and Scotland, but they were all works of a ponderous size and constructed pretty much after the plan of the "Britannica," consisting mainly of long treatises on the various departments of knowledge. The Messrs. Chambers, however, took as their model Brockhaus's well-known "Conversations-Lexicon," and have broken down, as they express it, the various masses of systematic knowledge, to as great a degree as is consistent with the separate explanation of the several fragments. No doubt this is the only satisfactory plan for a dictionary of universal information, which, first of all, ought to be a handy reference book. It is for this very reason that the alphabetical arrangement is used, and we do not see that much is gained by such an arrangement, if an encyclopædia is to consist of a collection of exhaustive treatises, requiring an enormous index to make them consultable. As a handy book of reference, then, the plan of "Chambers's Encyclopædia" is all that could be desired. Of course there is a limit to the cutting down of subjects for purposes of reference, and Dr. Findlater has shown great shrewdness and common sense in fixing this limit. Perhaps some might desire an encyclopædia with a more copious vocabulary, with a fuller list of subjects, more condensed information, and in every case where practicable a copious bibliography; but for the great bulk of the people, the encyclopædia before us will be found to answer with singular completeness all the purposes of a book of reference. Between the body of the work and the copious index there is little that any ordinary man will want to inquire about which he will not find information upon here, and that speedily. In many cases references to special authorities furnish the means of pursuing a subject further.

As to the quality of the work we can speak with almost unqualified approval. We have said that the "Encyclopædia" is modelled after the German "Conversations-Lexicon." Indeed, the Preface states that it was at first intended to translate almost literally the German work, but that after the work of translating had been gone on with for some time, it was seen that an encyclopædia adapted to the English public would have to be constructed on an independent basis. This has evidently been done. We have examined carefully a large number of the articles, and of course the scientific ones especially, and considering the purpose and plan of the work, there is really very little room for criticism. All the scientific articles have evidently been written by men who have special knowledge of their subjects, and as a rule are masterly specimens of condensation, clear statement, and wonderful fulness of information. Such names of contributors as Tait, Deutsch, Alex. Bain, Alex. Buchan, Goldstücker, Dr. G. E. Day, Keith Johnston, Dr. Birch, Pengelly, Francis Francis, and many others, are guarantees that in all the principal departments thoroughly competent men have been secured to write. But while with such contributors the quality of the information was bound to be up to the mark, the Encyclopædia would have suffered much in other respects without a thoroughly competent organising head. It is, no doubt, mainly due to Dr. Findlater that uniformity and due proportion have been secured, and that throughout perfect clearness has been maintained. His singular adaptation to fill the post of editor of such a work has largely contributed to its success.

But it is not only in the larger and more important articles that accuracy and care are apparent; even in the case of unimportant towns which may occupy only three or four lines, the information may be depended on, and in the case of British towns at least, was obtained, we believe, in almost every instance at first hand from some one on the spot. But down to the minutest details throughout the work constant and thoroughly intelligent and competent editorial care is evident, and if the Messrs. Chambers are careful to keep their work up to date, and bring out new editions at the proper times, they need hardly fear a rival.

The edition which lies before us is not strictly a new, but a revised edition; the work has not been reset, and but little increase has been made in the number of articles. We have, however, taken pains to compare some of the principal scientific articles in the new edition with the corresponding ones in the old, and in every case, where it has been really necessary for such a work, a competent revising hand is evident. "Chemistry," for example, which was first written twelve years ago, has been brought fairly up to date, and, as chemists know, this implies a great deal. By a few additional sentences in "Astronomy," the direction of the most striking recent researches is indicated; so in "Meteorology" and other articles. Indeed, it is quite evident that the work has been subjected to a thorough revision, and that considerable alterations have been effected, quite sufficient to keep the work fresh until a completely new edition is called for: not a few of the articles have been entirely re-written. The illustrations are copious and, in the main, accurate and well-drawn, and there is an excellent selection of maps.

Of course there are points in the work that are open to criticism; some subjects may seem inadequately treated, and others at too great length, and evidences of local bias are occasionally apparent, while there is a tendency in many of the biographical articles, to ambitious writing and the "higher criticism," which are a little out of place in a staid book of reference. But these are matters of comparatively small importance, in which Dr. Findlater is probably a much better judge than we. Of the sterling merits of the work throughout there can be no mistake, and it will long remain a monument of Messrs. Chambers's enterprise and public spirit, and of Dr. Findlater's practical skill, judiciousnes,s and power of organisation., not to say wide and accurate knowledge. Not its least merit is that, like all Messrs. Chambers's serial works, it was issued in weekly numbers at three-halfpence, and we would advise all who can spare the pittance to become possessed of this "golden treasury" of knowledge.

EGYPT AND THE NILE

Four Thousand Miles of African Travel: a Personal Record of a Journey up the Nile ana through the Soudan to the Confines oj Central Africa. By Alvan S. Southworth, Secretary of the American Geographical Society. (New York: Baker, Pratt, and Co. London: Sampson Low and Co., 1875.)

MR. SOUTHWORTH, we may at once state, has broken no new ground; he has simply followed what are now considered beaten paths, although fifteen years ago there would have been few European footprints on the route; nevertheless, Mr. Southworth has gathered much useful information. This is given to the public in an agreeable form, with a tinge of American humour in some descriptions that breaks the usual monotony of a book of travels.

It appears that the author's love of adventure prompted him to visit the Soudan in the hope of following and eventually joining the expedition under the command of Sir Samuel Baker, in Central Africa. In Chapter III., "The Start for the Soudan," he writes:—"Alarming rumours of the death of Sir Samuel Baker and his whole party had been freely circulated in Cairo." . . . "Such a great undertaking as the Baker expedition was regarded by many of the finest minds in Egypt as too gigantic to move successfully among the unknown wastes of Ethiopia. In the first place, it is taking an army into a country foul with the unhealthiest malarias, and charred to desert sands by the fiercest of African suns." . . . "Therefore, when news came from Khartoum that Sir Samuel Baker was in distress at some point of the Nile Basin, I prepared to go to the Soudan in order to investigate his position and condition." With this object Mr. Southworth started from Cairo in company with two American officers, Generals Starring and Butler, and after a winter journey through the Korosko Desert, the party arrived in Khartoum on the 6th of February.

Chapter XI. will well repay perusal by those who take a desponding view of Egypt's future. The description given of the extreme fertility and boundless resources of the Soudan may be to a certain extent overdrawn; but even with the deduction of fifty per cent., the value of the country remains enormous. At the period of Mr. Southworth's visit to Khartoum, Moomtaz Pacha was the new Governor-General of the Soudan, a Circassian of great energy, who was determined to develop the cotton-producing powers of his almost boundless territory. Unfortunately he had forgotten that a necessary step preliminary to cultivation was a railway from Cairo, as no means of transport existed beyond the limited conveyance by camels. "Tell the American people," said the Governor-General of the Soudan to Mr. Southworth, "that I have found a new America in the heart of Africa."

"Moomtaz Pacha, who had been there but four months and a half, had done more work than all his predecessors combined. He was the first man who appreciated the resources of this country; who formulated plans to utilise them; and who with a resolute hand began what I am firmly convinced will eventually come to be a prosperous empire, reaching from the equator to the tropic of Capricorn, and from the Indian Ocean to the Desert of Sahara."

Mr. Southworth's evidence is extremely valuable at this moment of general depression, when doubts have been expressed concerning the future prosperity of Egypt. There is the unanimous testimony from numerous travellers that a mine of agricultural wealth lies upon the southern limit of the great Nubian deserts, simply requiring a line of railway for its immediate development. There are lands in many portions of the globe that are adapted by soil and climate for the cultivation of cotton, but in most cases where such facilities exist there is a scarcity of labour. In the Soudan we find not only an apparently boundless extent of fertile soil where the cotton shrub is indigenous, but a large population is at hand who are only too ready to work for a fair remuneration. It may perhaps be forgotten by many that the ancient historian Pliny calls attention to the "wool-bearing trees of Ethiopia." In the days of Herodotus, whose descriptions of Egypt are so graphic, cotton was unknown, and the Egyptians were renowned for the manufacture of the finest linen from the native flax; it was only in the reign of Mehemet Ali Pacha, the grandfather of the present Khedive, that cotton was introduced into Egypt. Curiously enough, this was seed from the "wool-bearing trees of Ethiopia," which was brought into Egypt by an enterprising French traveller upon his return from the Soudan. When we consider the important assistance that was rendered to England by Egypt during the American civil war by an extraordinary effort in the production of cotton, we must feel a more than usual interest in the development of the vast cotton-producing resources of the Soudan. It is the natural hot-bed of the cotton plant, where it has existed from time immemorial; we have only to construct a railway either to the Port of Souakim on the Red Sea, or direct to Cairo according to the plan of Mr. Fowler, and the Soudan will at once deliver its vast burden of riches.

Mr. Southworth upon his arrival at Khartoum discovered that owing to the impediments to navigation caused by the vegetable obstructions on the White Nile, it was quite impossible to carry out his original idea of joining the expedition of Sir Samuel Baker. The enterprising Governor of the Soudan, Moomtaz Pacha, showed him every attention, and invited him to an excursion by steamer up the White Nile. During this voyage Mr. Southworth was struck by the extraordinary fertility of the soil in the vicinity of the river, together with the great advantages of water communication as a means of transport from the interior.

In spite of the vast natural resources of the country, Mr. Southworth, who was now fairly behind the scenes, quickly perceived the moral cancer that preyed upon the Soudan and completely paralysed all progress; this was the slave trade, which engrossed the attention and energies of the population. He writes (page 355): "A slave expedition starting under the title of an ivory enterprise means war. As high as 5,000 soldiers are employed by a single trader. Agãte had over this number on the White Nile; Cushick Ali, 4,000; Gatãse, 4,000; Bizelli, 800. Thus the slave trade in the valley of the Upper Nile is sustained by an active force quite as large as the standing army of the United States." . . . "By examining the most exhaustive consular statistics on the ivory trade, I find that no expedition could pay the first cost. The traders do not expect it; so that when you read of a great ivory trader you may substitute, with little fear of doing an injustice, 'an infamous slave-trader.'' At the time that Mr. Southworth's sympathies were enlisted against this abominable traffic, he thus speaks (page 216) of the Khedive's expedition under Sir Samuel Baker to suppress the slave-hunters: "As long as Baker remained a Pacha at Gondokoro (now Ismailïa) there was no danger of a direct White Nile slave trade. Indeed, the traffic may be said to have been closed." . . . "When I say 'direct slave trade,' I mean no slaves could be made to descend within the reach or knowledge of Baker Pacha. But unhappily he could not cover a whole continent." In page 213 he writes: "Sir Samuel Baker has been in that region its only vigorous European combatant, and more to him than any other man will be due the praise of its utter eradication, if the day ever arrives."

Mr. Southworth, as Secretary of the American Geographical Society, has a perfect right to express his opinions upon the "sources of the Nile," although he did not personally travel far upon the White River. He is somewhat perplexed by the pretensions of Col. Long, who, as a member of Col. Gordon's staff, travelled up to the capital of the King M'Tésé, with whom Sir Samuel Baker had established a permanent alliance. Col. Long, on his return from the Victoria N'yanza Bay, which forms the embouchure of the Victoria Nile exit (discovered by the late Capt. Speke), continued his course down stream by canoe to Foweera, the headquarters of Rionga. He reported that the mighty Victoria N'yanza was only fifteen miles broad, and that Speke had greatly exaggerated the size. He further reported that he had himself discovered an immense lake a few miles south of M'rooli (N. lat. 1° 36′), which he suggested was the "source of the Nile." These pretensions were never accepted by geographers, it being well known that at certain seasons the Victoria Nile floods many leagues of country above M'rooli; this would give a stranger an erroneous impression of a permanent lake. The recent explorations of Mr. Stanley, who claims to have coasted in his boat 1,000 miles of the Victoria N'yanza along the southern, eastern, and northern shores, is a sufficient refutation of Colonel Long's disparaging assertion that Capt. Speke's Victoria N'yanza was only fifteen miles across. Mr. Southworth with true discrimination suggests on page 302: "It is possible that Col. Long's lake was only the Nile in a very swollen condition; for I have seen the Nile at latitude 13° N. at very high water resemble a vast lake." On page 316 Mr. Southworth writes: "Dr. Livingstone's claims may be considered as out of the question. Lieut. Cameron has almost completely proven that Livingstone never saw the Nile, but that his operations were confined to the Congo Basin." On p. 317 the author thus summarises: "It practically reduces the Nile problem to this. The sources must be in the Albert and Victoria N'yanzas or their extensions; in the new lake of Col. Long; at the head waters of the Bahr-el-Ghazal, and in the sources of the feeders of the Blue Nile and the Atbara." We will dismiss the "new lake of Col. Long," but remind Mr. Southworth that he has omitted the most powerful of the White Nile affluents—the Sobat—N. lat. 9° 21′!

There can be no doubt the Victoria N'yanza is a mighty reservoir or principal source of the Nile, and the friends of the lamented Capt. Speke will rejoice in the triumph of his discovery now rendered certain by the survey of Mr. Stanley. The Albert N'yanza has never been visited by any Europeans except Sir Samuel and Lady Baker in February 1864; thus nearly twelve years have elapsed since its discovery, and yet no European has been able to reach its shores, although its waters were again sighted by Sir S. Baker during the expedition of the Khedive of Egypt.

There can be little doubt that Col. Gordon will succeed in exploring the Great Basin of the Nile, which will prove to be not only a source, but the general reservoir or basin that receives all equatorial affluents.

Although Mr. Southworth's travels do not include any new ground, his book affords much useful information, which will be received with more than ordinary interest at the present moment, when Egyptian affairs are prominently before the public.

OUR BOOK SHELF

Discoveries and Inventions of the Nineteenth Century. By Robert Routledge, B.Sc., F.C.S. With numerous Illustrations; pp. 594. (London: George Routledge and Sons, 1876.)

IN this book "an attempt has been made to present a popular account of remarkable discoveries and inventions which characterise the present century." "The instances selected have been those which appeared to some extent typical, or those which seemed to have the most direct bearing upon the general progress of the age." "The author has endeavoured to indicate, if not to explain, the principles involved in each discovery and invention."

These extracts from the preface sufficiently explain the object of the work before us. Anyone who attentively reads this book must admit that the author has succeeded in fulfilling the promise of his preface. He has produced a work teeming with useful and exact information presented in a singularly lucid and taking style. Of course this book cannot in any way take the place of the acknowledged manuals on the several subjects of which it treats, but it is admirably adapted to awaken an interest, especially among the young, in those wonderful advances which natural science has made in the present century; and to supply such a general knowledge as shall convey a correct idea of the principles on which the application of science to arts and manufactures are based, along with a sufficiently detailed account of these manufactures themselves.

Books, the general plan of which resembles that of this work, have been too often produced by men who had no scientific knowledge of the processes they attempted to describe, and have therefore shown a lamentable deficiency in exactness of detail and accuracy of theory. That the book before us should have escaped these faults, faults for which no brilliancy of diction or popularity of style can atone, is to be traced to the fact that its author has evidently determined, and has been able to carry out his determination, to make the book a scientific one; to show, as far as could be consistently with the general tone of the work, that theory is necessary for correct practice, and that correct practice reacts upon theory. The contents of the book include an account of steam engines, iron, tools, railways, steam navigation, fire-arms, printing machines, light, the spectroscope, electricity, photography, aquaria, india-rubber, explosives, mineral combustibles, coal gas, &c. A very interesting chapter is devoted to New Metals, in which a clear and succinct account of the discovery and present method of producing sodium, potassium, aluminium, and magnesium is given. The gradual diminution in the cost of these metals, and therefore their increasing application in manufactures as chemical science has discovered easier methods for their preparation, is an argument in favour of the study of pure science which must appeal, one would think, even to the Philistines.

The title which the author has chosen for the closing chapter of his book, viz. "The greatest discovery of the age," might lead one to look for a glowing account of some new invention to economise labour or to annihilate pain, but when we find that the chapter is devoted to a sober account of Dr. Joule's experimental determination of the mechanical equivalent of heat, and to some of the consequences deduced therefrom, we are but the more convinced that this book must rank among the few popular works which are sure to be of service in spreading a knowledge of the incalculable benefits which science has bestowed upon the human race.

M. M. PATTISON MUIR

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.*]

Scientific Research for the Promotion of Science

IN NATURE, vol. xii. p. 470, there are some valuable summaries of evidence taken before the Government Science Commission; but among them I was surprised to meet with the statement (by Captain Galton, R.E.) that, as one of the varieties of administration of several existing scientific institutions, "you have the Observatory at Edinburgh as part of the University of Edinburgh."

Now, inasmuch as I have for the last thirty years held the Directorship of the Edinburgh Observatory, by virtue of my appointment thereto signed by her Majesty, I should know something of the real facts of the case; and they oblige me to state that the Royal Observatory (the only Observatory) in Edinburgh is supported, in so far as it exists at all, by Government. It is responsible, moreover, solely to Government, in the person of the Principal Secretary of State for Home Affairs; it has never at any time received a farthing from the University of Edinburgh, whether for instruments, salaries, general maintenance, or particular services; and does not form any part of, nor belong to, nor did ever belong to, the said University in any manner whatever.

But the efficiency of the Observatory has been crippled from the beginning by the connection of its Director with the University; and as that offers a practical answer to the question much discussed in your pp. 429 and 470, touching whether there is, or is not, any difference in kind, nature, interests and feelings between institutions for the promotion of science by original observation on one side, and on the other the usually much larger and more numerous institutions for education,—I trust you will allow me a little space wherein to describe our actual and long-continued experiences here.

Built by the members of the late Astronomical Institution of Edinburgh between 1811 and 1830, this Observatory was, after many public petitions to that end, graciously taken up by Government in 1834, and its future utilisation secured by arrangements for the appointment thereto of a Royal Astronomer with an assistant, and a small allowance for ordinary working expenses. The first Astronomer so appointed was the late Thomas Henderson, the best man by far for such a post whom Scotland has ever possessed; and as he had at that time just returned from being Astronomer Royal at the Cape of Good

Hope, and had there secured and brought home the most astounding amount of both useful and even super-excellent astronomical observations that ever one man made in twelve months,—there was no apparent reason why he should not at once have been allowed to step straight into this new Observatory appointment, and commence its laborious duties forthwith.

But that was not to be; for he was privately informed that he must first and preliminarily be appointed a Professor in the University of Edinburgh. He started at and resisted the idea; he said he did not want to be a Professor, and would not be one; it was an occupation wholly foreign to his tastes, and entirely incompatible with the full and conscientious devotion of himself to being a working astronomer within the Observatory. Pressure, however, of powerful friends was brought to bear upon him; and he was made to understand that Government could not, or would not, whatever the secret reason, create and set agoing the new appointment for the Observatory on the Calton Hill, of "Astronomer Royal for Scotland," without first connecting it with a certain old and shameful sinecure in the University of Edinburgh, called the Professorship of Practical Astronomy.

He was indeed assured that he would, and should, never be called on to lecture in the Professorship; that it was a mere name and nothing more; and his form of appointment to the strangely and unnaturally duplex post of the old Professorship and the new Astronomer Royalship, was made out in words assigning clearly enough the work in the Observatory, of "with zeal and diligence making observations for the extension and improvement of astronomy, geography, and navigation, and other branches of science connected therewith," to be his only circle of duties and his only claim to salary, viz. 300*l.* per annum. But then how were those promises fulfilled; or rather, how were they neglected and overborne when the multitudinous heads of the great educational University of Edinburgh had once got poor Thomas Henderson, the first Astronomer Royal for Scotland, safe within their thrall as being also a Professor before them?

Why thus: they immediately began treading on his toes from every side; and with the most magnificent disregard that he had anything worthy of notice to do in the Observatory, they forced on his attention, both in season and out of it, "that while they were working so hard in the great educational hive, he was a mere drone, and yet was in receipt of a salary of 300*l.* per annum, an absolutely larger salary than any of themselves who bore the brunt and burden of the tuition of all the students." For the complainers, be it remarked, left out of view, that if their incomes did not mount up to 300*l.* in the shape of *salaries*, it was because they came to them chiefly in the form of students' fees; and in that phase sometimes reached 1,000*l.*, 1,300*l.*, and even 1,600*l.* per annum.

But this difference the teaching Professors could not see; and so, if, as they knew perfectly well, there were no students applying for Practical Astronomy Lectures, they determined that the Practical Astronomy Professor should still be educationally utilised, and as an assistant to other Professors, if not as a Professor on his own account. Wherefore Thomas Henderson was talked at, and talked at, until for one winter he was prevailed on to give lectures in the University to the Mathematical Class during the illness of its Professor. Then he was induced to take up the onerous position of Secretary to certain University trusts. And then, while that was still going on, he was over-persuaded into giving lectures for the then Professor of Natural Philosophy during one of his retirements; and then,—why, then, Thomas Henderson, who was all this time struggling almost superhumanly by night and by day to keep up his observations as Astronomer Royal for Scotland in the Royal Observatory, Edinburgh,—why, then—he died! Died too at the early age of forty-six years, and Scotland has not seen his like either before or since; for he was in fact the one and only high-class and complete practical astronomer whom his country and his nation have ever produced; and yet he was hurried to a premature grave, trampled on by an unsympathising *educational* University.

Of my own troubles in trying to fill this truly great man's place, I could tell a vast deal, but would rather merely refer to my last official Report to the Government-appointed Board of Visitors of the Royal Observatory, Edinburgh; wherein, after showing forth the recent attempts of the University authorities actually to "transfer" from the Astronomer Royalship of Scotland the *whole* of the salary originally appointed to that office by the Crown, and take it over to their own studentless Professorship, I have finally besought the Board to apply to Government to separate the two offices absolutely and for ever.

Most heartily convinced therefore must I be of the positive wisdom of those weighty words of Colonel Strange, alluded to in your p. 429; wherein, after stating his belief that there should be a Minister of Science, to look after the interests of institutions for *the promotion of science*, as entirely apart from any or all the institutions for *education*, whether in science or anything else, that most sage and experienced officer goes on to say:—

"That he considers education to be quite a different thing from national research, and that they should be kept as distinct as possible; and that one great evil now existing is the mixing up of those two things."

PIAZZI SMYTH,
Professor, and Astronomer Royal for Scotland
Royal Observatory, Edinburgh

Ericsson's Researches on the Sun

IN your interesting journal (vol. xii. p. 519) I see a description of an experiment by Capt. Ericsson, intended to measure the difference of temperature between the centre and the edge of the sun. I do not intend to make here any criticism on this experiment, but only to make some remarks on the final conclusions.

We must first distinguish two kinds of results—one directly given by the observation, the other by calculation.

In the first, we agree as far as is possible in considering the different methods of solving this question. He finds, indeed, that the intensity near the edge is 0·638 of that of the centre, the outer zone being in the mean line 49″ distant from the edge, and consequently large, 98″ = 1′ 38″. On my experimenting on a small area not exceeding one minute square, and distant from the centre 14′·920 = 14′ 55″·2 (and consequently distant in September from the edge 62″), I found 0·5586. The difference is indeed not very considerable, being 0·0794. Now Plana has shown, in the *Astron. Nachrichten*, No. 813, that such a small difference may lead to a very considerable difference in the value of the absorption.

The value of the solar atmospherical absorption, according to Mr. Ericsson, cannot be greater than 0·144 of the radiant heat emanating from the photosphere (page 520), and he then quotes my results, in which it is stated that 0·88 is absorbed by the whole atmosphere. He proceeds to remark: "It is unnecessary to criticise these figures presented by the Roman astronomer, as a cursory inspection of our table and diagrams is sufficient to show the fallacy of his computations."

I beg leave to observe that the fallacies are not only my own, but those of Laplace and Plana as well, who from the numbers of Bouguer's have arrived at a conclusion very similar to my own. The fallacy, I think, is rather in Mr. Ericsson's method of calculating. In a problem of so great difficulty, and where the great analysts have established very complicated formulæ, he makes use only of some very simple proportions, which are by no means justified, and with these he thinks his conclusion is very plain! I regret to say that such a method of computing in this case cannot be admitted, and consequently we are justified in attributing the difference of the results, not to the fallacy of our computation, but to the fallacy of those proportions assumed by Mr. Ericsson, unless he, or any competent mathematician, be able to show some great error in the formulæ of Laplace and of Plana.

Several objections besides may be made to his manner of experimenting, but of that on another occasion. In applying the numbers of Mr. Ericsson to the formulæ of Laplace and Plana, the result will be found to be not very different from mine. But at present I have no time to discuss these and other calculations, and also I wait for the new experiments which he has promised. I will only add that I do not share his opinion that the lenses and telescopes introduced in these researches by me do not give reliable results.

P. A. SECCHI,
Rome, Oct. 28 Director of the Roman Observatory

Sir G. B. Airy and the National Standards

IN NATURE vol. xiii. p. 35, the following statement occurs:—

"In the civic speeches which accompanied the ceremony [of conferring the Freedom of the City of London], great stress was laid on Sir G. B. Airy's services in connection with the Metric Standards."

This statement is not perfectly correct.

The expression of the Chamberlain of the Corporation, as recorded in the official register, and as correctly reported in the principal newspapers, was :—

"When the national standards of measure and ponderosity were by accident lost to the nation, you were applied to for the accomplishment of their restoration with that mathematical exactitude which was indispensable."

The statement in NATURE will be made correct by erasing the word "Metric" and substituting "National."

G. B. AIRY

The Origin of our Numerals

MR. DONISTHORPE's ingenious construction of our numerals by corresponding numbers of lines (NATURE, vol. xii. p. 476) induces me to offer a few remarks on this subject, which has a literature of its own. There can be no doubt, I believe, that our forms were derived directly from the Arab series called Gobar; that the Arabs had them from the Indians, and the Indians from the Chinese. My esteemed friend Dr. Wilson, of Bombay, published a "Note on the Origin of the Units of the Indian and European numerals," in 1858,* in which he showed the derivation of some of our numerals from ancient Indian forms found on cave inscriptions of Western India, on the Bhilsa Topes, and on coins. My remarks are founded wholly on the forms given in this note, which is little known, I believe, in England.

Dr. Wilson obtains our first four numeral forms from the Chinese, traced through different Indian script characters nearly as supposed by Mr. Donisthorpe. One, two, three horizontal bars and a square for 4. He also finds the eight in the forms , , and on the cave inscriptions.

Before proceeding to the other numerals I wish to notice a rule which may be deduced from the consideration of the changes in the forms of numerals in passing from one people to another, that the same form may be turned through angles of 90° or 180°, and may be inverted or reversed without altering its value. Even the same people have used a form turned in different ways for the same numeral. The Arabs used their 2, 3, and 4 in two ways, making angles of 90° with each other; the 2, 4, and 5 of Sacro Bosco and Roger Bacon were the Indian script Modi (and ours) turned through 180°, or upside down; other examples will be noticed.

The most important derivation by Dr. Wilson is that from the Chinese ten; this is found on the Bhilsa Topes with a circle round it (Dr. Wilson thinks to distinguish it from the oldest form of K found on the cave inscriptions). The nine is found on the Bhilsa Topes as , or one under ten, and on old coins thus: . The Indian caves give half of ten , , for five (as V is the half of the Roman ten, X). It is from this form that Dr. Wilson derives the Indian Modi and Nagari fives , , . It is here that I venture to differ slightly from Dr. Wilson. One of the cave forms of four is , which Dr. Wilson interprets (as in the case of nine) one under five, or five less one; now this form without the under bar, as well as the other forms of five, are, it seems to me, the halves not of the cross ( ) merely, but of the cross and circle thus: , , , which are as nearly as possible two half diameters and half circumference. The form is, I believe, the origin of our four, and not the Chinese or Indian square, as supposed. This I think will be evident when we compare the Arab four ( ) with the Indian four above. The Arab four s also employed thus: , which inverted gives , a sufficiently near approximation to our four.

Dr. Wilson has not been able to find the origin of our seven, but this is obtained from his Arab seven , by turning it round ( ) and making one leg shorter than the other, nearly resembling the Gobar seven . We may also find an earlier source in the Chinese seven turned round 180°, , which is almost exactly the German written seven. Neither six nor seven is to be found on the cave inscriptions. In Dr. Wilson's Arab series the Indian five is used for six, and the Gobar six, as well as ours, may be taken from the Nagari seven . We may also find an origin in the Chinese six , by omitting the horizontal bar, as in the case of the seven. That such liberties were taken is evident on a consideration of the five of Sacro Bosco and Roger Bacon ( ), the Indian five *without the bar*, and turned round 180°. If there is any merit in these suggestions it belongs to Dr. Wilson.

JOHN ALLAN BROUN

* See "India Three Thousand Years Ago." By John Wilson, D.D., F.R.S. (Bombay: Smith, Elder, and Co., 1858.)

On the Cup-shaped Joints in Prismatic Basalt

THE difference between Mr. Mallet (NATURE, vol. xiii. p. 7) and myself is simply this. He asserts, as necessary to his theory, that the "convexities" should always project in the direction in which the cooling and consequent "splitting is proceeding" ("Proceedings of the Royal Society," No. 158, p. 182). I referred him to the beautiful specimen, in the hall of the Geological Society's Museum, of three columns, one of which exhibits an articulation in the shape of a double-concave lens; the adjacent convexities consequently pointing, in this case, in *opposite directions*.

Mr. Mallet's reply to this is, that the cooling must have proceeded, in this instance, in different directions, and met in the biconcave-lens-shaped articulation. Now, inasmuch as this articulation is only a few inches (three or four) thick, and shows no sign of seam or separation across it, and Mr. Mallet himself declares (in the article mentioned above) that the plane which separates the part cooled from above, from that which cooled from below, "consists of irregular fragments," I maintain that his explanation is inadmissible and self-contradictory. Any geologist who takes sufficient interest in the question to examine the columns for himself will be easily satisfied on this point.

Nov. 8 G. P. SCROPE

A New Palmistry

THE proportions of the fingers in the two hands are not, I think, always the same. With me the index finger of the left hand is considerably longer than the ring; in the right they are very nearly equal. R. A. PRYOR

Hatfield, Nov. 12

OUR ASTRONOMICAL COLUMN

THE MINOR PLANETS.—The discovery of No. 154 by M. Prosper Henry at the Observatory of Paris, on November 6th, is announced in M. Leverrier's Bulletin and by circular with the "Astronomische Nachrichten;" and that of No. 155 by Herr Palisa at Pola on the 8th inst., in the Paris Bulletin of the 13th. They are of the same magnitude (twelfth) as the three previously detected during the present month.

The rapid increase in the number of small planets must soon occasion serious difficulty, not only in predicting their positions with sufficient approximation to allow of their being recognised without considerable expenditure of time and trouble, but likewise in securing observations, especially on the meridian, according to the system pursued for some years past at Greenwich and Paris, by agreement between the Astronomer Royal and M. Leverrier.

As regards the preparation of ephemerides, it is well known that the conductor of the "Berliner Astronomisches Jahrbuch," Prof. Tietjen, makes it a speciality of his work, with the aid of a numerous body of astronomers in various parts of Europe and in the United States, and hitherto he has succeeded in providing observers with an ephemeris of nearly every small planet detected to within a short time of publication. Thus, in the Jahrbuch for

1877, we find approximate places for 1875, of 134 out of 138 planets—materials for calculation not being available in four cases—and accurate opposition-ephemerides are given where the elements have been perturbed to the year, and for those planets for which Tables have been prepared. The initiated in these matters will be aware that a work of this extent involves a vast amount of labour, which will be greatly increased with the present rate of discoveries of new members of the group of small planets.

In some few instances the perturbations have been determined with every possible precision, with a particular object in view, as in the case of Themis, the motion of which was rigorously investigated by Dr. Krüger, for a determination of the mass of Jupiter; and for those planets whose perturbations have been thrown into the form of Tables, it was also necessary to settle the elements with great accuracy, though the results have not been in every case so satisfactory as might have been expected. We have now Tables of Amphitrite, by Becker; of Iris, Flora, and Victoria, by Brünnow; Egeria, by Hansen; Metis, Lutetia, and Pomona, by Lesser; and of Parthenope, Eunomia, Melpomene, and Harmonia, by Schubert.

Even with approximate places of these bodies, so long as they are situated within about 3° from the ecliptic, the charts of small stars now in the hands of astronomers allow of their being identified without much difficulty with the equatorial, and the errors of the predicted places being determined by this instrument, their meridional observation is greatly facilitated. Still, rough ephemerides must be prepared, and a considerable amount of time will be involved in ascertaining their errors, and as observations made with this purpose in view may be so conducted as to give positions pretty nearly as reliable as those generally resulting from meridional observations, we shall not be surprised to learn that the latter are soon relinquished, except perhaps for the older minor planets and for such as attain the brightness of stars of the eighth or ninth magnitude, and are accurately predicted. The subdivision of labour as regards observations does not appear to have so far worked very efficiently, though proposed many years since—another effort, however, may be necessary in this direction, and it may at least be expected that those who by their discoveries are so rapidly increasing the list of planets, will keep them in view for a sufficient length of time to allow of their elements being well determined.

Egeria, which has now about the brightness of an average star of the ninth magnitude, is favourably situated for observation; it has lately passed amongst the outliers of the Pleiades. The following places are for Berlin midnight:—

	R.A. h. m. s.	N.P.D. ° ′	Distance from earth.
Nov. 18	3 18 59	65 53·3	1·478
,, 20	3 16 32	65 47·8	1·479
,, 22	3 14 6	65 42·6	1·481
,, 24	3 11 42	65 37·7	1·484
,, 26	3 9 21	65 33·1	1·488
,, 28	3 7 3	65 28·8	1·493

Lutetia, a bright eleventh magnitude, is approaching opposition. Places, also for Berlin midnight, are:—

	R.A. h. m. s.	N.P.D. ° ′	Distance from earth.
Nov. 18	4 54 11	68 34·1	1·480
,, 20	4 52 8	68 35·0	1·477
,, 22	4 50 1	68 36·1	1·474
,, 24	4 47 52	68 37·3	1·472
,, 26	4 45 40	68 38·6	1·472
,, 28	4 43 26	68 40·0	1·472

SCIENCE TEACHING TO YOUNG CHILDREN

THE leading article in NATURE of Oct. 28, on the Sixth Report of the Science Commission has made me think that possibly a short account of an attempt to teach science to boys younger than those to whom that report refers, may be not without interest for some of your readers.

There are at present about fifty boys in this school, varying in age from seven to fourteen, the majority of whom are going to one or other of the great public schools. In order to attain the high standard of classical work necessary, half the school-hours have to be given up to Latin and Greek. Enough time still remains, however, even after providing for the requirements of mathematics, French, and the usual English subjects, to enable every boy to learn either botany or chemistry. For this purpose the school is divided into three classes, the lowest of which contains about twenty boys, whose average age is nine. Class II. is composed of ten boys of an average age of twelve, while the first class contains twelve boys of an average age of twelve and a half. Class III. has two lessons in botany of three-quarters of an hour each, and one hour's lesson on physical geography in the course of the week. The boys in it are taught to distinguish the parts of a flower, and by the help of a chart similar to that given by Mrs. Kitchener in her "Year's Botany" to discover the order to which any plant belongs. The winter is employed in learning the chart, and in studying the characters of the different orders as shown on Henslow's Botanical Diagrams. Illustrations taken from Sir John Lubbock's and Mr. Darwin's books, of the relations between plants and insects, and facts bearing on the geographical distribution and economical uses of plants, add interest to these lessons. The second class also does botany, but is able to give two-and-a-half hours per week to it. The standard of knowledge aimed at is such as is contained in Prof. Oliver's or Mrs. Kitchener's books and the boys are expected to be able to find out any given plant in Bentham's British Flora. The boys in Class I. learn chemistry, and spend one afternoon of one-and-a-half hours at practical work in a small laboratory. Another afternoon is employed in listening to a lecture founded upon Miller's Chemistry (Text-books of Science series). Two additional half-hours are given to getting up the portion of Miller lectured on, so as to be able to answer questions on it at the beginning of the next lesson. The boys have also to keep notes of the lectures and of the laboratory work. The standard aimed at is the power to discover a simple acid and base, and an acquaintance with the text-book. During the summer the chemistry boys have a botany lesson once a fortnight, in order that they may keep up what they had previously learned. In addition to this regular work, Classes I. and II. have occasional lectures either on chemical physics, "Erdkunde," or some such subject. As regards marks, all the various school subjects stand on an equal footing.

The science lessons are very popular with the boys, as is shown by their frequently referring to them out of school, and by their occasionally bringing home plants in order to make them out. But we hope that the boys will retain some considerable amount of knowledge beyond the mere power of making out the flowers given to them, or that of doing simple analysis, and though perhaps few of the younger boys would be able to pass a thoroughly satisfactory *written* examination, in either chemistry or botany, yet a good deal more knowledge might be questioned out of even them by an experienced examiner than they would be able to put upon paper. Mere knowledge of the facts of either science is not the object at which we have been chiefly aiming. These sciences were chosen less as subjects of study than as instruments of training in order to cultivate the powers of observation, and to encourage a habit of inductive reasoning. If the teaching of science in its early stages is thus regarded more as a means than as an end, there is no child, who has begun to learn anything at all, who may not be taught some branch of it with advantage.

At the same time there is a danger to be avoided.

When we first began teaching botany and chemistry here, I was so strongly impressed by the truth of this view of the proper place of science in education, that I started by making the boys examine flowers and do simple reactions without making them learn anything by heart, hoping to induce them to collect their facts and build up their science for themselves. The result was that they did not know what to do with the facts which they collected, and kept losing them as fast as they picked them up. But since the botany boys have been set to learn the chart by heart, and since the chemistry boys have been using a text-book, the progress made has been far more satisfactory. A young child's reasoning powers are so feeble that he needs to be constantly guided in the use of them, and before being set to observe he requires to be furnished with a "cadre" in which to arrange his battalions of facts.

It may be asked why botany and chemistry should be chosen in preference to other sciences, such as geology or physics, which might seem likely to prove more attractive to boys. Botany was chosen because it is purely a science of perception, of observation and co-ordination of existing facts, and because it calls into play and directs into a useful channel that natural propensity of boys to collect and classify which is seen in butterfly catching and stamp albums. A good deal more might be made of entomology than has hitherto been attempted, but it is rather a holiday than a school subject, the bases of its classification are too minute and even arbitrary, and it has the disadvantage of leading almost of necessity up to subjects too wide for boys to grasp. Chemistry was chosen because it is a science of reflection, and forms the best introduction to the experimental method. In chemical analysis a boy has first to produce the results on which he must afterwards exercise his reason; he has to reflect on and draw his conclusions from not only what he sees, but what he does. He thus learns never to do anything without knowing why he does it and what result he expects to obtain. Chemistry also has the advantage of giving a first insight into the practical applications of mathematics. That indeed is the part of the subject which the majority of boys find most difficult. It is rare to find a boy who will readily work out arithmetically even a simple reaction. In the only possible rival to chemistry—physics—the simpler phenomena are much less varied and interesting, the bond of union between them is less apparent, the reasoning from effect to cause less patent, and there are comparatively few experiments which a child could perform for itself. Physics form an admirable lecture subject, but even then the necessary mathematical reasoning is far beyond the capacity of an average boy of twelve. Such subjects as geology and astronomy may be made most interesting, and a great deal may be done by directing children's attention to the physical actions going on in the world around them, but they are what, from a schoolmaster's point of view, I should call informational rather than educational sciences, their phenomena are generally too vast for a child's mind really to exercise itself upon them.

It will have been noticed that in no case are we able to give to science the full six hours per week recommended by the Commissioners. I would gladly do so, but do not think that it would be possible unless the standard for the classical entrance scholarships at the public schools, which of necessity fixes that of the first class at private schools, were lower than it is now, and although the entrance scholarships have raised this standard considerably above what it was only a few years ago, yet I do not think that it would be desirable to lower it, at least in translation and grammar. In composition, and especially in verse composition, I think it is a matter for consideration whether classical scholarship really benefits by expecting so much from very young boys; whether they would not learn to appreciate the delicacies of style more quickly and thoroughly if they did not spend so much time over artificial composition before they have gained that natural facility of expressing their thoughts in their own tongue which only practice and varied reading can give; and whether therefore some part of the time now given to that subject might not, in many cases at least, be more usefully employed on other subjects, such as science and English composition, or perhaps drawing, in which boys naturally take a keen interest, and which certainly tend to give breadth of view and largeness of mind, and what is equally important, "a ready wit." Even in translation boys fail much oftener from want of knowledge of English than from want of power to construe. At present the number of entrance scholarships in which science counts for anything is so small that they may be disregarded, and certainly nothing could be less desirable for the interests of science itself, or more productive of "cram," than for scholarships to be given to boys in science alone. Would it not, however, be possible for the classical composition standard to be lowered in a considerable number of scholarships, and for one-third or one-half of the marks in them to be given to science, including practical work? The remaining scholarships might keep to their present standard in every respect, a standard which is certainly not at all too high for boys who possess real literary power, and possibly not for average boys who do not seem to possess any special bias either towards the literary or the scientific side. A plan of this sort would avoid giving that encouragement to "modern sides" which would be given by special science scholarships, and that would be an advantage, for any bifurcating arrangement is always practically very difficult to work, and has never yet produced a satisfactory result either in science or in classics.

The Commissioners are, I believe, in the right in thinking that education should be brought under the great law of progress from the more general to the special, and that it will be quite soon enough for any ordinary student to begin to concentrate all his energies on that particular line of study which is likely to prove the most valuable to him in his future career, when he has entered the university, and ought therefore to be of such an age and discretion as to be able to decide for himself what will be the probable course of his future life. From this opinion it is true that Prof. Stokes dissents, on the ground that "a wider discretion should be left to the governing bodies or head masters as to the degree to which what has been called 'stratification' of studies should be carried out." Now I am convinced, not only from theory, but from practical experience, that though stratification is undoubtedly the right course for an adult to pursue, yet that the advocates of that system do not make sufficient allowance for the intense love of novelty innate in a child, nor for the incapacity of a brain not fully developed of sustained application to any one subject. We have been led here, little by little, to diminish the length of the lessons in every subject until now scarcely any lesson exceeds half, or at the most three-quarters, of an hour in length; and the masters all agree in saying that with fairly intelligent boys they can get quite as much work done in the shorter time as in the longer. No boy can fix his attention on one subject for long together, and the moment it flags he might just as well be out in the playground as in the school-room. But if, before he has got weary of one subject, another which interests him is brought before him, he will turn to it with as much zest as if he were just beginning work. It has more than once happened that a boy in this school has needed to give special attention to certain subjects. Formerly I used to take such a boy out of his less important classes, in order that he might give extra time to his special subject. But in no case have we found that such a boy at the end of the term has made any sensible progress beyond his fellows who had continued doing their ordinary more varied work. Though some part of this might be owing to his being outside the regular classes, yet by far the greater part was due to the monotonous work palling upon him and dulling his brain.

The education of young children should be made like their picture-books. The pictures should be such as will induce the little learner to read and study the letterpress in order to find out more about them, and for that purpose they can scarcely be too numerous. A boy when his mind first opens to the world around him is like a man in a large strange house. He must needs go about and learn the arrangement of the building, peer into every room, examine the varied prospect from every window, before he can decide which rooms he will make his own; but when once he has made his choice, he will probably keep to one or two rooms and seldom enter the others.*

G. HERBERT WEST

Ascham House School, Bournemouth

THE THEORY OF "STREAM LINES" IN RELATION TO THE RESISTANCE OF SHIPS†

THE address of the President of a Section would year by year possess an appropriate interest, if it could always consist of an exposition of the progress made during the past year in the department of science which the Section embraces. And many of the addresses to this and other sections have conformed to this pattern with marked success.

But the adequate preparation of an address shaped in this approved mould would require a range of experience and a grasp of thought such as few possess; and custom has wisely sanctioned a type of address which, though less appropriate to the occasion, need not be either uninteresting or inapposite. And we, in this Section, have not to search far for instances in which its President has charmed and instructed us by a masterful exposition of some single subject in practical science, or by a timely reminder of the improvident manner in which we deal with some precious store of natural wealth.

I must express a hope that it will not be regarded as a conversion of liberty into license, if the subject I have chosen obliges me to introduce a further innovation, and to use diagrams and experiments in order to make my meaning clear.

I propose to treat of certain of the fundamental principles which govern the behaviour of fluid, and this with special reference to the resistance of ships. By the term "resistance" I mean the opposing force which a ship experiences in its progress through the water.

Considering the immense aggregate amount of power expended in the propulsion of ships, or, in other words, in overcoming the resistance of ships, I trust you will look favourably on an attempt to elucidate the causes of this resistance. It is true that improved results in ship-building have been obtained through accumulated experience; but it unfortunately happens that many of the theories by which this experience is commonly interpreted, are interwoven with fundamental fallacies, which, passing for principles, lead to mischievous results when again applied beyond the limits of actual experience.

The resistance experienced by ships is but a branch of the general question of the forces which act on a body moving through a fluid, and has within a comparatively recent period been placed in an entirely new light by what is commonly called the theory of stream-lines.

The theory as a whole involves mathematics of the highest order, reaching alike beyond my ken and my purpose; but I believe that, so far as it concerns the resistance of ships, it can be sufficiently understood without the help of technical mathematics; and I will endeavour to explain the course which I have myself found most conducive to its easy apprehension.

It is convenient to consider first the case of a completely submerged body moving in a straight line with uniform speed through an unlimited ocean of fluid. A fish in deep water, a submarine motive torpedo, a sounding lead while descending through the water, if moving at uniform speed, are all examples of the case I am dealing with.

It is a common but erroneous belief that a body thus moving experiences resistance to its onward motion by an increase of pressure on its head end, and a diminution of pressure on its tail end. It is thus supposed that the entire head end of the body has to keep on exerting pressure to drive the fluid out of the way, to force a passage for the body, and that the entire tail end has to keep on exerting a kind of suction on the fluid to induce it to close in again—that there is, in fact, what is termed *plus* pressure throughout the head end of the body, and *minus* pressure or partial vacuum throughout the tail end.

This is not so; the resistance to the progress of the body is not due to these causes. The theory of stream-lines discloses to us the startling but true proposition, that a submerged body, if moving at a uniform speed through a perfect fluid, would encounter no resistance whatever. By a perfect fluid, I mean a fluid which is free from viscosity, or quasi-solidity, and in which no friction is caused by the sliding of the particles of the fluid past one another, or past the surface of the body.

The property which I describe as "quasi-solidity" must not be confused with that which persons have in their minds when they use the term "solid water." When people in this sense speak of water as being "solid," they refer to the *sensation* of solidity experienced on striking the water-surface with the hand, or to the reaction encountered by an oar-blade or propeller. What I mean by "quasi-solidity," is the sort of stiffness which is conspicuous in tar or liquid mud; and this property undoubtedly exists in water, though in a very small degree. But the sensation of solid reaction which is encountered by the hand or the oar-blade, is not in any way due to this property, but to the *inertia* of the water: it is in effect this inertia which is erroneously termed solidity; and this inertia is possessed by the perfect fluid, with which we are going to deal, as fully as by water. Nevertheless it is true, as I am presently going to show you, that the perfect fluid would offer no resistance to a submerged body moving through it at a steady speed. It will be seen that the apparent contradiction in terms which I have just advanced is cleared up by the circumstance, that in the one case we are dealing with steady motion, and in the other case with the initiation or growth of motion.

In the case of a completely submerged body in the midst of an ocean of perfect fluid, unlimited in every direction, I need hardly argue that it is immaterial whether we consider the body as moving uniformly through the ocean of fluid, or the ocean of fluid as moving uniformly past the body.

The proposition that the motion of a body through a perfect fluid is unresisted, or, what is the same thing, that the motion of a perfect fluid past a body has no tendency to push it in the direction in which the fluid is flowing, is a novel one to many persons; and to such it must seem extremely startling. It arises from a general principle of fluid motion, which I shall presently put before you in detail—namely, that to cause a perfect fluid to change its condition of flow in any manner whatever, and ultimately to return to its original condition of flow, does not require, nay, does not admit of, the expenditure of any power, whether the fluid be caused to flow in a curved path, as it must do in order to get round a stationary body which stands in its way, or to flow with altered speed, as it must do in order to get through the local contraction of channel which the presence of the stationary body practically creates. Power, it may indeed be said, is first expended, and force exerted to communicate certain motions to the fluid; but that same power will ultimately be given back, and the force counterbalanced, when the fluid yields up the motion which has been communicated to it, and returns to its original condition.

I shall commence by illustrating the action on a small scale by fluid flowing through variously shaped pipes; and I must premise that in the greater part of what I shall have to say, I shall not require to take account of absolute hydrostatic pressures. The flow of water through pipes is uninfluenced by the absolute pressure of the water.

I will begin with a very simple case, which I will treat in some detail, and which will serve to show the nature of the argument I am about to submit to you.

Suppose a rigid pipe of uniform sectional area, of the form shown in Fig. 1, something like the form of the water-line of a vessel.

The portions AB, BC, CD, DE are supposed to be equal in length, and of the same curvature, the pipe terminating at E in exactly the same straight line in which it commenced at A, so

* My experience has been entirely with boys, but I feel sure that elementary science might be taught with at least equal advantage to little girls.

† Address to the Mechanical Section of the British Association, Bristol, August 25, 1875; by William Froude, C.E., M.A., F.R.S. President of the Section. Revised and extended by the author.

that its figure is perfectly symmetric on either side of C, the middle point of its length.

Let us now assume that the pipe has a stream of perfect fluid

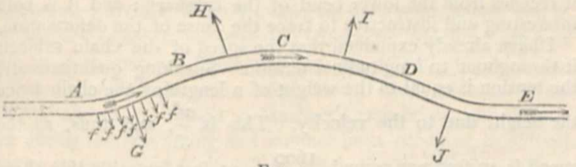

FIG. 1.

running through it from A towards E, and that the pipe is free to move bodily endways.

It is not unnatural to assume at first sight that the tendency of the fluid would be to push the pipe forward, in virtue of the opposing surfaces offered by the bends in it—that both the divergence between A and C from the original line at A, and the return between C and E to that line at E, would place parts of the interior surface of the pipe in some manner in opposition to the stream or flow, and that the flow thus obstructed would drive the pipe forward; but if we endeavour to build up these supposed causes in detail, we find the reasoning to be illusory.

I will now trace the results which can be established by correct reasoning.

The surface being assumed to be smooth, the fluid, being a perfect fluid, can exercise no drag by friction or otherwise on the side of the pipe in the direction of its length, and in fact can exercise no force on the side of the pipe, except at right angles to it. Now the fluid flowing round the curve from A to B will, no doubt, have to be deflected from its course, and, by what is commonly known as centrifugal action, will press against the outer side of the curve, and this with a determinable force. The magnitude and direction of this force at each portion of the curve of the pipe between A and B are represented by the small arrows marked *f*; and the aggregate of these forces between A and B is represented by the larger arrow marked G. In the same way the forces acting on the parts BC, CD, and DE are indicated by the arrows H, I, and J; and as the conditions under which the fluid passes along each of the successive parts of the pipe are precisely alike, it follows that the four forces are exactly equal, and, as shown by the arrows in the diagram, they exactly neutralise one another in virtue of their respective directions; and therefore the whole pipe from A to E, considered as a rigid single structure, is subject to no disturbing force by reason of the fluid running through it.

Though this conclusion that the pipe is not pushed endways may appear on reflection so obvious as to have scarcely needed elaborate proof, I hope that it has not seemed needless, even though tedious, to follow somewhat in detail the forces that act, and which are, under the assumed conditions, the *only* forces that act, on a symmetrical pipe such as I have supposed.

Having shown that in the case of this special symmetrically curved pipe the flow of a perfect fluid through it does not tend to push it endways, I will now proceed to show that this is also the case whatever may be the outline of the pipe, provided that its beginning and end are in the same straight line.

Assume a pipe bent, and its ends joined so as to form a complete circular ring, and the fluid within it running with velocity round the circle. This fluid, by centrifugal force, exercises a uniform outward pressure on every part of the uniform curve; and this is the only force the fluid can exert. This pressure tends to tear the ring asunder, and causes a uniform longitudinal tension on each part of the ring, in the same manner as the pressure within a cylindrical boiler makes a uniform tension on the shell of the boiler.

Now, in the case of fluid running round within rings of various diameter, just as in the case of railway trains running round curves of various diameter, if the velocity along the curve remain the same, the outward pressure on each part of the circumference is less, in proportion as the diameter becomes greater; but the circumferential tension of the pipe is in direct proportion to the pressure and to the diameter; and since the pressure has been shown to be inversely as the diameter, the tension for a given velocity will be the same, whatever be the diameter.

Thus, if we take a ring of doubled diameter, if the velocity is unchanged, the outward pressure per lineal inch will be halved; but this halved pressure, acting with the doubled diameter, will give the same circumferential tension.

Now this longitudinal tension is the same at every part of the ring; and if we cut out a piece of the ring, and supply the longitudinal tension at the ends of the piece, by attaching two straight pipes to it tangentially (see Fig. 2), and if we maintain the flow of the fluid through it, the curved portion of the pipe will be under just the same strains as when it formed part of the complete ring.

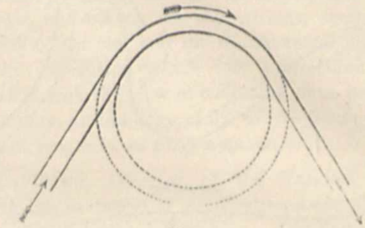

FIG. 2.

It will be subject merely to a longitudinal tension; and if the pipe thus formed be flexible, and fastened at the ends, the flow of fluid through it will not tend to disturb it in any way. Whatever be the diameter of the ring out of which the piece is assumed to be cut, and whatever be the length of the segment cut out of it, we have seen that the longitudinal tension will be the same if the fluid be moving at the same velocity; so that, if we piece together any number of such bends of any lengths and any curvatures to form a pipe of any shape, such pipe, if flexible and fastened at the ends (see Fig. 3), will not be disturbed by the

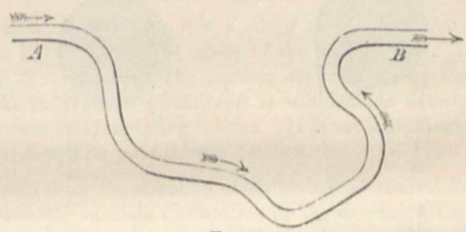

FIG. 3.

flow of fluid through it; and the equilibrium of each portion and of the whole of the combined pipe will be satisfied by a uniform tension along it.

Further, if the two ends of the pipe are in the same straight line, pointing away from one another (see Fig. 4), since the

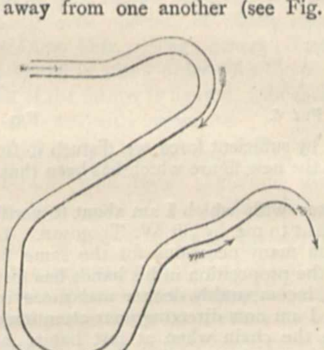

FIG. 4.

tensions on the ends of the pipe are equal and opposite, the flow of the fluid through it does not tend to push it bodily endways.*

This is the point which it was my object to prove; but in the course of this proof there has incidentally appeared the further proposition, that a flexible tortuous pipe, if fastened at the ends, will not tend to be disturbed in any way by the flow of fluid through it. This proposition may to some persons seem at first sight to be so paradoxical as to cast some doubt on the validity of the reasoning which has been used; but the proposition is nevertheless true, as can be proved by a closely analogous experiment, as follows:—

Imagine the ends of the flexible tortuous pipe to be joined so as to form a closed figure (see Fig. 5), there will then be no need for the imaginary fastenings at the ends, since each end will

* See Supplementary Note A.

supply the fastening to the other. Then substitute for the fluid flowing round the circuit of the pipe, a flexible chain, running in the same path. In this case the centrifugal forces of the chain running in its curved path are similar to those of the fluid flow-

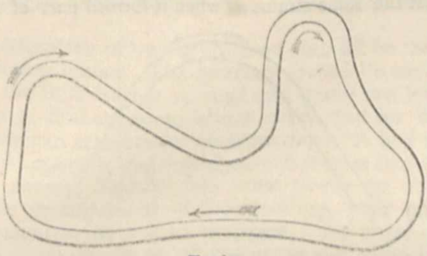

FIG. 5.

ing in the pipe; and the longitudinal tension of the chain represents in every particular the longitudinal tension on the pipe.

As a simple form of this experiment, if a chain be set rotating at a very high velocity over a pulley in the manner shown in Fig 6, it will be seen that the centrifugal forces do not tend to disturb the path of the running chain; and, indeed, the velocity being extremely great, the forces, in fact, tend to preserve the path of the chain in opposition to any disturbing cause. On the

FIG. 6.

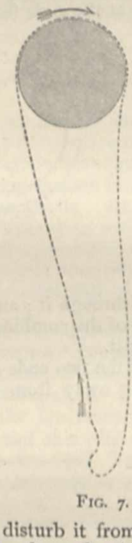

FIG. 7.

other hand, if by sufficient force we disturb it from its path, it tends to retain the new figure which has been thus imposed upon it (see Fig. 7).

The apparatus with which I am about to verify this proposition has been lent to me by Sir W. Thomson. It is one which he has used on many occasions for the same purpose; and I must add that the proposition in his hands has formed the basis of conclusions incomparably deeper and more important than those to which I am now directing your attention.

You observe the chain when at rest hangs in the ordinary catenary form, from a large pulley with a very wide-mouthed groove and mounted in a frame which is secured to the ceiling. By a simple arrangement of multiplying bands the pulley is driven at a high speed, carrying the chain round by the frictional adhesion of its upper semi-circumference. When at its highest speed the chain travels about 40 per second.

The idea that the chain when thus put in motion will be disturbed by its centrifugal force from the shape it holds while at rest must point to one of two conclusions; either (1) the chain will tend to open out into a complete circle, or (2) it will on the contrary tend to stretch itself at its lower bend to a curvature of infinite sharpness.

But you observe that no tendency to either change of form appears. On the contrary, the chain, instead of taking spontaneously any new form in virtue of its centrifugal force, has plainly assumed a condition under which it is with difficulty disturbed, alike from its existing form, or from any other which I communicate to it by violently striking it. Such blows locally indent it almost as they would bend a bar of lead.

In spite, however, of this quasi-rigidity which its velocity has imparted to it, it does, if left to itself, slowly assume, as you perceive, a curious little contortion, both as it approaches and as it recedes from the lower bend of the catenary; and it is both interesting and instructive to trace the cause of the deformation.

I have already explained that the speed of the chain subjects it throughout to longitudinal tension. Speaking quantitatively, the tension is equal to the weight of a length of the chain twice the height due to the velocity. This is $\frac{v^2}{g}$, and thus, as the speed is 40 feet per second, $\frac{1600}{32} = 50$ feet, or with this chain about 14 lbs.

Now in travelling through the lower bend of the catenary, the chain passes from being nearly straight, to being sharply curved and immediately straightened again, and this change of form involves a continued pivoting of link within link, the friction being called into action by the tension which presses the surfaces together. Each link thus in succession resists this pivoting with a definite force, and the resistance, in effect, converts what appears to be a perfectly flexible combination into one possessing a tangible degree of stiffness, and the oblique attitude assumed by the chain as it approaches the bend, and the slight back turn which it assumes as it emerges from the bend, are alike consequences of this factitious stiffness.

For in virtue of gravity, the running chain, like the chain at rest, tends always to maintain the original catenary; and in virtue of its speed of rotation, it seeks to maintain (not preferentially the catenary, but) whatever form it for the moment possesses. Hence its departure from the true catenary was, as you saw, gradual. But when the figure of equilibrium is once attained, the persistency of form imparted by velocity serves to maintain this figure as indifferently as any other. Hence the figure is that in which equilibrium subsists between the force of gravity seeking to restore the catenary, and the factitious stiffness resisting the necessity of bending and unbending.

The slowness with which the form is assumed, and its steady persistency when once assumed, alike bear witness to the truth of the proposition which it is the object of the experiment to verify.

The stream of fluid in the tortuous flexible pipe would behave in a strictly analogous manner.

(To be continued.)

NOTES

IT is with great regret that we hear of the death of Dr. von Willemöes-Suhm, the distinguished naturalist assisting Prof. Wyville Thomson in the *Challenger*. Information of the sad occurrence has just been received at the Admiralty.

AT the opening meeting of the Royal Geographical Society on Monday, the president, Sir H. Rawlinson, reviewed the progress of the Society and of geographical discovery during the past year. He announced that the Prince of Wales, the Vice-patron of the Society, had just sent the Society, as the first geographical result of his tour in the East, a very interesting collection of route-maps of Upper Egypt and its recently acquired dependencies, which had been executed in the Topographical Department of the Egyptian War Office by General Stone, Chief of the Etat Major, from materials furnished in one direction by Col. Gordon and the officers serving under his orders, and in another by Col. Purdy and the officers of the Darfur Expedition. These maps contain much new geographical matter. The President referred with great satisfaction to Stanley's exploration of the Nyanza, and exhibited a complete chart of the lake drawn by Stanley. As to Col. Gordon, who by last accounts had reached Appudo, 140 miles from the Albert Nyanza, if he could overcome the eight miles of rapids which lay before him, he would probably reach the Albert Nyanza with his steamer the *Khedive*, before Stanley. Both Gordon and his assistant Chipendall report, from native information, that the Nile leaves the Albert Nyanza by two channels. Dr. Pogge and Dr. Lasaulx, the only remaining members of the German African expedition, have shifted their ground to the south, with the intention of starting from the Loanda base, and making their way *viâ* Cassange to the mysterious capital of Matiamno. The President then referred to Capt. Trotter's work on the Panjah River, and to the Russian scientific expedition to Hissar, by which we are now able to construct a reliable map of the country between the Upper Oxus and Jaxartes. Sir Henry then spoke of New Guinea, and of the failure of Macleay's expedition. D'Albertis has during the late spring and summer been occupied in natural history researches on Yule Island, while the Rev. S. Macfarlane and Mr. Stone have discovered and ascended for a distance of sixty miles a large river on the south coast of New Guinea. The river is from one to a quarter mile broad, and from three to twelve fathoms deep, and might easily be made navigable for more than 100 miles. It is proposed to call it the Baxter River. At the close of his address, the President observed that at the next meeting the subject of the Victoria Nyanza will be fully gone into, and that the discussion on that subject had better therefore be reserved until that occasion. Mr. W. L. Watts afterwards read a paper on his journey last summer across the Vatna Jökull, Iceland.

THE *Daily Telegraph* of Monday contains Mr. Stanley's letter which was sent home by the unfortunate Col. Linant de Bellefonds. It is dated "Mtesa's Capital, Uganda, April 12," and is principally occupied with an account of Mr. Stanley's voyage round the southern, eastern, and north-eastern shores of the Victoria Nyanza. His exploration has evidently been made with great care, and he has ascertained with considerable certainty that Speke was right in regarding the Nyanza as only one lake. It is, however, evidently thickly studded with islands, and its coast much broken up into bays and creeks by long promontories from the land. Stanley was most hospitably received and magnificently entertained by Mtesa, who, since Speke saw him, has, with his people, turned Mahommedan. Stanley speaks of him with the greatest respect, and believes that he might be made a most effective instrument for the civilisation of the region surrounding his capital. The *Telegraph* of Tuesday contains Mr. Stanley's map of the Nyanza, neatly reproduced.

MR. JAMES STUART, Fellow of Trinity College, has been elected Professor of Mechanism and Applied Mechanics at Cambridge University.

WE understand that the Council of the Scottish Meteorological Society have resolved to commence an investigation into the habits of the salmon. The point which is first to be investigated is the question of the earliness or lateness of the different rivers, and for this purpose they have entered into communication with Mr. Archibald Young, Fishery Commissioner, at whose suggestion various early and late rivers have been selected, and arrangements have already now been made for carrying on the necessary observations on the river Ugie, Aberdeenshire.

WE have received six large temperature and rain charts of the United States, constructed by Mr. Charles A. Schott from observations collected by the Smithsonian Institution, which show by lines the distribution of temperature for every 4° from 36° to 76°, and of rainfall for every two or four inches during summer, winter, and the year. The principle on which the temperature charts have been constructed, and which was fully described in NATURE in reviewing the annual chart in the small form in which it was first published, consists in representing actual mean temperatures, uncorrected for elevation. The whole form a set of six charts illustrative of the most prominent features of the climatology of the United States, and are calculated to prove of great utility in many practical matters.

THE Report of the Commission appointed by the Prussian Government for the scientific investigation of the Baltic and North Sea, for 1872 and 1873, has just been published. The Report (pp. 380), which is a very valuable one and well illustrated, contains discussions on the fisheries of the German coasts, by Dr. V. Hensen; and on the physical observations made at the various stations of the Commission, by Dr. G. Karsten; together with interesting papers by Dr. H. A. Meyer, Dr. P. Magnus, Dr. K. Möbius, and others, on the currents, temperature, and specific gravity of the sea, and on the botanical and geological results of the expedition which was undertaken during the summer of 1872 with the view of collecting data bearing on the physics, chemistry, and biology of the North Sea. We hope to examine this at length in an early number.

DR. BURMEISTER, Director of the National Museum of Buenos Ayres, has in course of preparation a complete scientific description of the Argentine Republic. The first volume, containing the history and geography, is already in the press. The second, containing the meteorology, physical geography, and biology, is in preparation. The work is in German, but the Argentine Government has undertaken a French translation of it.

DR. BURMEISTER has also nearly ready a description of a complete skeleton of the Fossil Horse of Buenos Ayres (*Hippidium neogaeum*, Owen), of which but fragmentary portions have been previously known.

AN important work on the Zoology of Eastern Asia will appear in Russia before the close of the current year. It will comprise the results of the journey undertaken by Colonel Przevalski in Western China, and it will include descriptions of many new and interesting species. It is not improbable that a translation will be published in English.

WE would draw the attention of our biological readers to Mr. G. E. Dobson's valuable Conspectus of the sub-order, families, and genera of Cheiroptera, arranged according to their natural affinities, in the "Annals and Magazine of Natural History" for this month.

WE have received Prof. Cope's systematic catalogue of Vertebrata of the Eocene of New Mexico collected in 1874, containing the account of forty-seven species, of which twenty-four are described for the first time. The genera *Bathmodon* and *Uintatherium* are placed in a new order—Amblipoda—by themselves, and the foot of the former is figured, with three phalanges to the hallux, which is evidently inaccurate.

WE have also received a paper by Prof. O. C. Marsh, on the *Odontornithes*, or birds with teeth, containing illustrations of parts of *Ichthyornis dispar* and *Hesperornis regalis*.

MR. W. H. DALL, of the U. S. Coast Survey, has published the results of his examination of Mount Saint Elias, Mount Fairweather, and other peaks of the range which skirts the coast of the narrow strip in the south of Alaska; Mount St. Elias, however, really seems to be in British territory. Very various heights have been given to the latter from La Pérouse downwards, varying from 12,600 to 17,800 feet, the British Admiralty Chart making it 14,970 feet. Mr. Dall, from many careful observations, gives the height as 19,500 feet, with a possible error either way of 400 feet. Mount Fairweather he gives as 15,500 feet; Mount Crillon, 15,900 feet, with possible error of 500 feet; Mount Cook, 16,000 feet; Mount Vancouver, 13,100 feet; and Mount La Pérouse, 11,300 feet, the last three being approximate. The names of Cook and Vancouver have been given by Mr. Dall to two high peaks of the St. Elias range to the southward and eastward of St. Elias; to a high peak near the sea, at Icy Cape, he has given the name of La Pérouse; Mount Crillon is to the south of Mount Fairweather. The following are the geological conclusions at which Mr. Dall arrives with regard to this range:—That these Alps are, like the high Sierra of California, mainly composed of crystalline rocks, and in their topography, their small, pustular, basaltic vents, their associated marbles, quartzites, and later conglomerates, exhibit a close parallel to the Sierras; that parallelism in structure and composition implies parallelism in age and method of formation; and, finally, that the volcanic origin of the high peaks is opposed not only by analogy, but by the known facts." An examination of the clear sketches certainly seems to bear out Mr. Dall's conclusion that these peaks are not ot the volcanic type.

LONDON has at last come in for her share of the disasters by flooding which have devastated so many river valleys in England and on the Continent. An unprecedentedly high tide caused the Thames to overflow its banks on the south side very early on Monday morning, flooding the streets and houses of Lambeth and other low-lying districts all along that side of the river, from Woolwich even to Kingston, we believe. The damage caused has been very serious and extensive, several feet of water rushing at one time through many streets on the south side, even at a considerable distance from the river. No one seems to have expected an unusual tide, though in March last year a similar phenomenon was looked for; the tide then, however, was seven inches lower than that of Monday. It is supposed that a very high spring tide with a strong gale blowing is the cause of the disaster.

THE force of the last hurricane in Paris was so great that its maximum could not be measured at the Montsouris Observatory, the magnetic anemometer having been broken by the rush of wind. The rate measured by Robinson's cups exceeded 70 kilometres per hour, when the apparatus was put out of order by the excess of central force.

MR. WILLIAM SANDERS, a well-known geologist in the West of England, died on Friday at his residence at Clifton, aged 76.

A COURSE of twelve lectures, by Mr. E. Bellamy, on the Anatomy of the Human Form, commenced last Monday, in connection with the National Art Training School, South Kensington. There are to be twelve lectures in all, to be delivered on Monday evenings.

WITH reference to the subject of the use of the movements of the sea as motive powers, referred to in NATURE, vol. xii. p. 212, Señor Don Eduardo Benot writes that the subject has been a study with him for many years, and he will be pleased to correspond with anyone who may wish to obtain information on the subject. Señor Benot's address is Barquillo 5, Madrid, Spain.

ACCORDING to a report presented by Count Hallez d'Arros to the Managing Committee, the Exhibition of Electrical Appliances, to be held at Paris in 1877, will be divided into the following groups:—1. History of Electricity; 2. Apparatus for Demonstration; 3. Piles and Batteries; 4. Electro-magnetism; 5. The Electric Telegraph; 6. The Electric Light; 7. Electric Motors; 8. Electrotyping; 9. Therapeutic Electricity.

A CORRESPONDENT at Belfast has sent us specimens of the caterpillar of *Arctia caja*, telling us at the same time that during this season, in which they have been particularly numerous, he has noticed that they have done much injury to textile fabrics laid on grass to bleach, by perforating them in circular holes, specially during sunshine after rain. The holes they make vary in size, some being very small, others large enough to admit the body of the animal. They are usually in clusters, and each is generally surrounded by a greenish coloured matter, apparently ejected by the caterpillar. This habit of *Arctia caja* is quite new to entomologists.

WE have received in a separate form, reprinted from the report of Major J. W. Powell's Exploration of the Colorado River of the West and its tributaries, a lengthy paper by Dr. Elliott Coues on the North American cheek-pouched rodent genera *Geomys* and *Thomomys*. The number of species of the former is given as five; of the latter two, of which one, *T. clausius*, is new, and is figured life size.

THE French Minister of Marine is establishing at the Depot of Maps, a new office for meteorology, which will be in some respects in connection with the Meteorological Office of the National Observatory. It will be placed under the control of Capt. Mouchez.

THE numerous reports as to the occurrence of a remarkable marine animal on the coast of New England during the past summer have induced the Boston Society of Natural History to prepare and distribute a circular calling for information on the subject.

IN a Congregation held at Oxford on Nov. 10, Prof. Bartholomew Price, Warren De la Rue, D.C.L., John Dale, M.A., and William Esson, M.A., were duly appointed visitors of the University Observatory. This is the first appointment of such visitors. The Observatory, which has been lately completed, took its rise, as our readers know, in the munificence of Dr. De la Rue.

MR. GEORGE SMITH, of the British Museum, left London last week for the East, to resume his researches in Assyria. He will be absent six months.

MESSRS. W. and A. K. Johnston have published a very clear map of India, to illustrate the travels of the Prince of Wales. It is on the satisfactory scale of seventeen miles to an inch, is fairly full but not too crowded with names, and has the proposed route of his Royal Highness clearly shown. Of course the route is liable to be altered, but anyone will be able to follow the Prince in the map without effort. Side by side with the principal map is a neat map of England on the same scale, showing at once the comparative sizes, and the fact that our country is only about twice the size of Ceylon. There is also a map of part of Europe, Asia, and Africa, showing the route from England to India. The blue surface of the wide Bay of Bengal has been utilised for a number of useful statistics concerning India. Anyone interested in following the Prince's route will find this map of great service.

THE success of the geographical play "Round the World in Eighty Days" has encouraged another Paris theatre to try an astronomical drama under the title of "Travels in the Moon." But the only astronomical part of the performance is a large moon which is exhibited in front of the theatre, showing to an admiring crowd the principal features of Beer and Madler's well-known lunar map.

CAPTAIN SOUTER, of the *Intrepid*, from the Davis Straits whale fishing, reports that while anchored in Isabella Bay on the 13th August he found it necessary, in consequence of the great body of ice coming down, to proceed on shore. After sailing some distance he came into a fine commodious natural harbour, not marked in the charts. There was nothing to show that it had ever been entered before. Captain Souter and other officers left in a cairn a writing indicating the discovery. Splendid water was found.

THE additions to the Zoological Society's Gardens during the past week include a Beisa Antelope (*Oryx beisa*) from Central Africa, presented by the Seyyid Burgash of Zanzibar; two Central American Agoutis (*Dasyprocta punctata*) from Central America, presented by Capt. E. Hairby and Mr. W. J. Henderson respectively; a Grey Ichneumon (*Herpestes griseus*), from India, presented by Mr. John Jennings; a Spotted Ichneumon (*Herpestes auropunctatus*) from Nepal, presented by Mr. L. B. Lewis; a Plantain Squirrel (*Sciurus plantani*) from Java, presented by Master E. H. Cole; a Malbrouck Monkey (*Cercopithecus cynosurus*) from E. Africa, presented by Mr. C. L. Norris Newman; a Dufresne's Amazon (*Chrysotis dufresniana*) from S. E. Brazil, presented by the Rev. A. Hibbet; a Mona Monkey (*Cercopithecus mona*), a Campbell's Monkey (*Cercopithecus campbelli*) from W. Africa, deposited.

THIRD REPORT OF THE SETTLE CAVE COMMITTEE (VICTORIA CAVE) *

WORK has been carried on almost uninterruptedly throughout the year (except from March 20th to May 20th, when it was stopped for want of funds), at a cost of 175*l.* 12*s.* 7*d.* Of this, 80*l.* 11*s.* 9*d.* was a balance in hand, 50*l.* the British Association grant, and 45*l.* 0*s.* 10*d.* raised by private subscription.

Great progress has been made in the past year in uncovering the glacial deposits at the entrance of the cave, and showing their relation to the older bone-beds containing the remains of man with the extinct animals. The boulders are seen to cover an area of at least 1,200 square feet.† They are of all sizes, and consist of dark and white Carboniferous Limestone, and the basement bed of that formation, Carboniferous Gritstone, and Silurian Grit. Some have travelled at least two miles, and others greater distances. They are various in size, from mere sand-grains to blocks several tons in weight. An interesting section was displayed, showing the passage of the boulder-beds in one part from a regular till with large scratched stones, through scratched gravel, sand, to laminated clay, and these were so interbedded as to demonstrate that some at least of the laminated clay is of glacial age and origin.

At length, after six years' work, we are able to say that we have reached the floor of the cave at the entrance. Several pinnacles of rock have been found by the removal of the boulders; they run in lines parallel with the joints of the rock above, and give testimony to the cave having been at some time occupied by a stream, similar rock-weathering occurring in other water-caves in Craven. The arched niches on the right of the cave at the entrance lead to the same conclusion.

And now, with the additional evidence of another year's diggings, we may again consider the question, the most interesting perhaps of all the problems before us: Are the glacial deposits which rest upon the older bone-beds, containing the extinct mammals and man, in the position which they occupied at the close of the glacial conditions, or have they subsequently fallen into their present site? We may again urge the reasons given last year (see Second Report), strengthened by enlarged sections and a wider experience, which go to prove the first alternative. To these arguments we may now add the following:—That the extent of the glacial deposits now exposed is so great that it is impossible that they can be a mere chance accumulation of boulders which have been re-deposited in their present position since glacial times. This being the case, it is clear from the position of the boulders beneath all the screes, that they are a portion of the general glacial covering of the valleys and hillsides which was left by the ice-sheet at the time of its disappearance.

These are the main arguments to be derived from the cave itself, but further strong presumptive evidence, that the Pleistocene fauna lived in the North of England before the ice-sheet, exists as follows:—The older fauna once lived in this district, a point which admits of no dispute from its existence in the Victoria Cave, in Kirkdale Cave, Raygill Cave in Lothersdale, and perhaps in other caves. But their bones are now found nowhere in the open country. None of the river-gravels contain them; and just that district which is conspicuous by their absence, is also remarkable for the strongest evidences of great glaciation. Putting these facts together, the probability is very strong that it was glaciation that destroyed their remains in the open country. To suppose that these have been destroyed by other sub-aërial agencies, would be to ignore the fact that in the South of England and other non-glaciated areas, such remains exist both in the caves and river-gravels.

A few bones were found lying upon the boulders beneath the talus. They have been determined where possible by Prof. Busk, but they are only fragmentary and not of much interest; they were probably washed out of the Lower Cave-earth when it was exposed above the edge of the boulders. No fragments of bone were found throughout the 19 feet of talus which lies between the base of the Neolithic layer and the top of the boulders.

Work in Chamber D.—A considerable amount of work has been done in excavating this chamber which leads off from the principal entrance towards the right. It was choked to the roof over the greater part of its extent, with clay and limestone blocks. It is now 110 feet long, 20 feet wide, and 20 feet high at the entrance. Two galleries lead off from it on the right. One, the Birkbeck Gallery, is made easily accessible for a distance of 44 feet, in a N E. direction. Here it becomes very narrow and leads to a narrow chasm 20 feet deep. The other gallery is blocked at the entrance with stalagmite.

A magnificent series of bones was found in Chamber D. They were all carefully registered as to their position by Mr. Jackson. The Committee are much indebted to Prof. Busk for his kindness in determining them. He says: "They are a remarkably interesting collection, especially in the Bears, and I think the larger of the two skulls is by far the finest specimen of the kind yet found in this country."

"Out of about 269 specimens including detached teeth,

127	belonged to	Bear	
37	,,	,, Hyæna	
36	,,	,, Bos	
24	,,	,, Fox	
22	,,	,, Deer	15 Red Deer 7 Reindeer
10	,,	,, Rhinoceros	
2	,,	,, Horse	
1	,,	,, Badger."	

To these we may add 1 of Pig, 2 of Elephant, and 1 of Hippopotamus. The Rhinoceros is *hemitœchus*, the Elephant *antiquus*, and the Hippopotamus, a portion of a tusk, is the only specimen of that animal found in the course of six years' digging. The careful registration of the remains has enabled your reporter to construct a section showing the distribution of the different animals throughout the different portions of the deposit. It is too bulky for publication, but the result may be given in words. The bones group themselves along two horizons separated by a greater or less thickness of laminated clay, cave-earth, and stalagmite. The lower extends from the back of the boulder-beds at the cave mouth, is continuous with that which contained the human fibula, and runs continuously as far as Parallel 42. The upper bed commences only at Parallel 15, close against the roof, and continues to Parallel 43. Where the upper bed commences, the two horizons are about twelve feet apart, but they gradually approach other, and at Parallel 35 not only touch, but seem to be somewhat commingled.

From this section we find that the following species are—

Peculiar to the Upper Bed.	Peculiar to the Lower Bed.	Common to both.
Badger.	Hyæna.	Man.
Horse.	Brown Bear?	Fox.
Pig.	*Elephas antiquus*	Grisly Bear.
Reindeer.	*Rhinoceros hemitœchus.*	Red Deer.
Goat or Sheep.	Hippopotamus.	
	Bos primigenius.	

Brown Bear has previously been found in the upper beds in other parts of the cave. The upper bed probably contains remains from the Reindeer period to the present, those of later date being mixed up with older in the mud at the surface. But as distinguished from the lower bed, the chief characteristics of the upper appear to be the presence of the Reindeer, and the absence of Elephant, Rhinoceros, Hippopotamus, and Hyæna.

In the upper bed the only sign of man's presence consists of the spinous process of a vertebra of a bear which has been hacked apparently by some cutting instrument with a tolerably regular edge. It might have been done with a bronze celt or polished flint axe. It is probable that Chamber D was never the resort of man within the historic period. The soft wet mud of the floor, and the lowness of the roof, render it most unlikely that anyone would take to it, except under the direst necessity, or in the pursuit of science.

In the lower bed again evidence of man's presence is but scanty. At the mouth, and close to where the human fibula was found, we have this year met with a piece of rib apparently nicked by human agency. The nicks appear to have been made by some clumsy instrument drawn backwards and forwards. They are in character totally unlike the square-troughed gnawings of rodents, and the furrows heavily ploughed by the teeth of carnivores.

And now, having restricted ourselves to the hard road of

* Abstract. Read at the Bristol meeting of the British Association, August 1875, by R. H. Tiddeman, M.A., F.G.S.

† The full report will contain two photographic plates giving a general view of the cave and a nearer view of the boulders.

fact, we may, perhaps, in conclusion, be permitted to indulge in a short flight of fancy. Let us endeavour to realise how great is the distance in time which separates the savage of Craven from our own day. We have the history of much of it in the Victoria Cave itself, and we may restore some of the missing pages from the surrounding district.

At the cave, Roman times are separated from our own by sometimes less than one, but not more than two, feet of talus, the chips which time detaches from the cliffs above. The Neolithic age, which antiquaries know was a considerable time before the Roman occupation, is represented by a layer in some places four or five feet beneath the Roman, in others even running into it. Then comes a thickness of 19 feet of talus without a record of any living thing. Judging by the shallowness of the Roman layer, this must represent an enormous interval of time. And this takes us down to the boulders, the inscribed records of the Glacial Period. They must represent a long series of climatal changes, during which the ice was waxing and waning, advancing and melting back over the mouth of the Victoria Cave. This period saw the Reindeer and the Grisly Bear occasionally in possession. Then we have an unconformity, a break in the continuity of the deposits, the boulders lying on the edges of the older beds. Time again! and that time long enough for changes to take place which allowed the district to cool down from a warmth suitable to the Hippopotamus, and become a fitting pasture-ground for the Reindeer. It was in that warm period that the early Craven savage lived and died.

But these are not all the changes which occurred in the North of England since that time. The age of the great submergence represented by the sea beaches of Moel Tryfaen and Macclesfield, and by the Middle-Sands-and-Gravels of Lancashire, has left no record up at the cave. Your reporter is of opinion that the submergence did not attain in that district a greater depth than six or seven hundred feet, and this would still leave the cave 750 feet above the sea, though it would cut up the land into a group of islands. The fact is sufficient for us, the depth is immaterial.

Upon no fact are geologists better agreed than upon the existence of a wide-spread submergence and emergence of land towards the close of the Glacial Period. No tradition is common to more races and religions than that of a great deluge. Where back in the past is the common point whence these two far-travelled, almost parallel rays of truth had their origin? In the opinion of your reporter the Craven savage who lived before the Great Ice-sheet, and *before the Great Submergence*, may form another of the many strong ties which bind together the sciences of Geology and Anthropology.

GERMAN SCIENTIFIC AND MEDICAL ASSOCIATION*

THE following communications were made to the various sections. Of many of these papers our space permits us to give little more than the titles and names of authors:—

Section 1. *Astronomy and Mathematics*.—The laws of comets, by M. von Hauenfels.—On the idea of space, by Prof. Hoppe. —On properties of tetragons between hyperbolas, by Prof. Reitlinger.—On the criteria of maxima and minima in definite integrals, by Prof. Zmurko.—On Voigtländer's newest telescopes, by A. Martin.—On the mathematical series called chains, by Dr. Günther.

Section 2. *Physics and Meteorology*.—The new polariscope of Mach, by Dr. Subic.—The glimmer combination of Reusch and their significance for theoretical optics, by Dr. Sohnke.—The relation between the temperature and the inner friction of gases, by Capt. Obermeyer.—Dr. Prestel showed his climatographical atlas of Germany.—On changes of induction-currents through iron nuclei, by A. Ettingshausen.—On the isogonic lines in Transylvania, by G. Schenzl.—On microscopical photography, by A. Martin.—On the increase of the velocity of evaporation through electricity, by Dr. Reitlinger.—On the temperature of steam given off by solutions of salts, by L. Pfaundler.—Method of representing the various constituents of weather in a short and exact manner, by Dr. Prestel.—The conducting powers of several acids for electricity, by Prof. Kohlrausch.—On mirror observations with minute mirrors, by Prof. Boltzmann.

Section 3. *Chemistry*.—On a new colouring matter, phloröin, by R. Benedict (already published in the *Annalen der Chemie*).—R. Böttger proved that Gore's inflammable antimony contains not only chloride of antimony, but also occluded hydrogen, transforming, as it does, ferricyanide into ferrocyanide of potassium. The same chemist has found glycerine to preserve palladium-hydrogen for three months or longer. The same chemist also showed a new solvent for tri-nitro-cellulose, viz., sodic sulphydrate.—Dr. Schwartz showed the oxidation of ammonia to nitric acid by means of hypermanganate of potassium. —Dr. Meusel proved the transformation of ammonia in water into nitrites to be due to the presence of bacteria, and to be prevented by benzoic, carbolic, or salycilic acids, that kill the bacteria.—A. Mitscherlich showed a new air-thermometer.—A. Butlerow presented observations on the transformation of hydrocarbons C_nH_{2n} into alcohols.—The same chemist has found a phenol $C_{15}H_{24}O$ in the juice of *Cynanchum acutum*.—L. v. Pebal showed new apparatus for disengaging gases, and new thermometers for lecture purposes.—A. Michaelis reported on the continuation of his experiments on aromatic compounds of phosphorus.—H. v. Richter on the action of cyanide of potassium on nitro-compounds, and on the transformation of aromatic amides into bromides.—M. Conrad on dichloro-aceto-acetic ether.—H. Schacherl demonstrated that hydrochloric acid and chlorate of potassium yield hypochlorous acid:—

$$2KClO_3 + 4HCl = 2ClO_2 + 2H_2O + Cl_2 + 2KCl.$$

—E. Urban communicated that phosphoric anhydride transforms allylic alcohol, not into allylene, but marsh-gas.—Prof. Butlerow insisted upon the necessity of introducing dynamical views into the constitution-theory of chemical molecules, and explained his intentions by drawing attention to the various decompositions which both cyanic and hydrocyanic acids offer under different circumstances.—I. Iobst sent a communication on a Bolivian bark *Quina cota*, which is free from quinine, but contains $1\frac{1}{2}$ per cent. of a new crystalline body not yet analysed.

Section 4. *Mineralogy and Geology*.—On a Labyrinthodont found near Brünn, by A. Markowsky.—Geology of the Vienna Waterworks, by F. Karrer.—On minerals enclosed in the volcanic conglomerates of the Swabian Alps, by Prof. Nies. —On the Brown-coal Flora of Styria, by C. von Ettingshausen.—On Baer's law respecting the flowing of rivers of a southern direction, by A. Dunker.—On the influence of plants for diminishing the surface of lakes, by Dr. Senft. —On a fossil resin, Hartit, by Dr. Hofman.—On the magnesites of Styria, by Prof. Rumpf.—On the results of deep borings in the North German Plain, by Dr. Huysser.—On the granites of the mountain-range, Böhmerwald, by Dr. Woldrich.—On earthquakes (trying to demonstrate the action of the moon on subterranean volcanic eruptions), by R. Falb.—On the falling in of abandoned coal-mines in Königshütte (Silesia), by Dr. Serlo. —On eruptive formations in the Fassa-valley and Fleimser-valley, by C. Dölter.—On a discovery lately made near Stuttgart, of eighteen Saurians, partly measuring as much as 0·9 metres in length, by Dr. Karpff.—On corals in Tertiary sediments of Krain, by W. Linhart.

Section 5. *Botany*.—C. von Ettingshausen communicated phyto-palæontological studies in their bearing on the transformation of species; also a paper on the transformation of *Castanea atavia* into *Castanea vesca*.—Dr. Eidam described the development of the sexual organs of Hymenomycetes.—On high pressure in the cells of plants, by Dr. Pfeffer.—On morphology of cryptogamea, by Dr. Prantl.—On the flora of Australia and of the Cape, by C. v. Ettinghausen.—On the sexual life of plants, by E. Strasburger.—On the vegetation of Mount Etna, by G. Strobl.—On Theophrastus as a botanist, by O. Kirchner. —On a monstrous organ in *Marchantia polymorpha*, by Prof. Leitgeb.—On acclimatising *Rheum Ribes* in Vienna, by Prof. Fenzl.—Morphology of mosses (Lebermoose) and application of phenol and essential oil of cloves for botanical preparations, by H. Leitgeb.

Section 6. *Zoology and Comparative Anatomy*.—On the zoological station at Trieste, and on a sponge, *Sycandra raphanus Haeckel*, by F. E. Schulze.—On the genus Myzostomum, by L. Graff.—On the penis of Scolytides and the chewing apparatus of the same genus, by Prof. Lindemann.—On *Ptychoptera contaminata*, by C. Grobben.—On the circulation of molluscs, by Prof. Kollmann.—On the curves described by the legs of insects, by V. Graber.—On noctilucous Dipteræ at the Aral lake-district, by W. Aleuitzin.—On the ear of Heteropodes, by Prof. Claus. —On *Podocoryne carnea*, by C. Grobben.—The typical forms of the skulls of cattle, by Dr. Wilckens.—On the differentiation in certain species of beetles (*Carabus monilis*, *arrogans*, and

* Continued from p. 34.

Ullrichii) produced by climate, by Dr. Kraatz.—On the anatomy of Turbellariæ, by L. Graff.

Section 7. *Anatomy and Physiology.*—On the texture of the cerebrellum of man, by B. Stilling.—On the time necessary for developing muscular currents, by H. Hermann.—On the nervus vagus, by Dr. Steiner.—Application of anilin-red for microscopical objects, by E. Hermann.—Contribution to the physiology of muscles, by Prof. Auerbach.—On Newton's law of temperatures with regard to animal heat, by A. Adamkiewicz.—Prof. Gscheidlen proved that the activity of nerves is connected with oxidising processes.—On the retina of snakes, by Dr. Flesch.

The Sections 8 (*Pathology*), 9 (*Medicine*), 10 (*Surgery*), 11 (*Ophthalmology and Otiatrics*), 12 (*Midwifery*), 13 (*Psychiatrics*), 14 (*Hygiene*), 15 (*Military Surgery*), and 20 (*Diseases of Children*), being devoted to medicine, must be omitted in this report; excepting, however, a paper read in Section 9, by Dr. Knapp, on the Styrian habit of arsenic-eating. The speaker introduced two men, fifty-five and twenty-five years old, who had been in the habit of eating arsenic for years, the former having contracted this habit in 1849, to save himself (in his opinion) from an epidemic of typhus then raging. The other, a farm-servant, applied arsenic to improve the health of cattle, and accustomed himself to its use. They have gradually increased the dose to about 0·5 gram. As_2O_3 or As_2S_3, taken once a week. They swallowed before the eyes of the Section 0·3 gr. of orpiment and 0·5 gr. of arsenious acid respectively. Only strong people seem to adopt this habit, and they do not appear to suffer in health through it. With women it has been known to produce abortus (see also Section 17).

Section 16 "Naturwissenschaftlische Paedagogic" (*on the Teaching of Science in Schools*) was composed of teachers, who discussed the means for teaching and the extent to which science should be taught in schools.

Section 17. *Agricultural Chemistry.*—On estimating atmospheric carbonic acid, by Dr. Fittbogen.—On experiments made in the agricultural station of Proskau on the influence of shearing in increasing the weight of sheep (it being found that shearing increases their appetite), and on the influence of arsenic in fattening animals, by O. Kellner. It appears that arsenic increases the power of digesting fat, and decreases the amount of nitrogen given off in urine, thus assisting materially in the formation of flesh.—On potato-feeding, by Dr. Wolf.—On the specific weight of seeds and on the bearing of analytical results on the physiological value of seeds, by G. Marck.—On fibrous plants and their cultivation in moors for the purpose of paper-making, by H. Stiemer.—On the value of animal protein, by Dr. Wild.—On the proportion of solid and liquid matter in plants in different periods of their vegetation, and on the decrease of salts in water used for watering fields in Westphalia, by Dr. König.—On the solubility of phosphates of lime, and on the treatment of bones with superheated steam, by Dr. Krocker.

Section 18. *Geography and Ethnology.*—Prof. Friesach explained a table destined for mariners to facilitate the finding of the shortest route between two points of the globe.—Dr. V. Zwiedinesk reported on a journey to the Wan Lake (Curdistan).—Von. Hochstaetter showed Mr. Mundy's photographs of New Zealand.—On the course of the Arctic vessel *Tegethof*, by Vice-Admiral Baron Wüllerstorff.—On Arctic ice, by Lieut. Weyprecht.—On the project of connecting the Algerian-Tunisian plain (Chotto or Sebkhas) with the Mediterranean, by G. Stache. The author is of opinion that the advantages of this (Capt. Rondaire's) project are not in proportion to its difficulties and costs.—On Dante's views on the advancing and receding of the sea, by W. Schmidt.

Section 19. *Anthropology.*—On prehistorical remains (urns) at Maria-Rast, near Marburg (Styria), by Prof. Müllner. This burial-ground was visited by the Section, as also the field near Leibnitz, where various bronzes have been found, and the tumuli near Purgstall; Count Wurmbrand acting as guide.—The latter reported on burial-grounds in Upper Hungary.—On a burial-ground near Innsbruck, by Dr. Wieser.—On Slavian legends, by Prof. Müllner.—On Keltic remains in Styria, by F. Ferk.—On the cavern of Byci-Scala in Moravia, by H. Wankel.—On diluvial man, by Count Wurmbrand.—On lake-cities (Pfahlbauten) in the moors of Laibach, by Dr. Deschmann.—On prehistorical walls and ditches in Hungary, by Dr. Romer.—On the natural law of the formation of states, by L. Gumplowicz.—On prehistorical measures, by R. v. Luschin.—On Keltic warfare, by Dr. Weiss.

A. OPPENHEIM

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, Nov. 11.—Prof. Cayley, F.R.S., in the chair.—Prof. Sylvester, F.R.S., gave an account of results arrived at in his communication "on the fifteen young ladies problem and a general mathematical theory of pure syntax." The problem, which was first considered by Mr. Sylvester more than twenty-five years ago, was not at that time published by him: it was then discussed by Prof. Cayley, next proposed by Rev. T. P. Kirkman in the "Lady's and Gentleman's Diary" for 1850: solutions were given in the "Diary" for 1851; but it was not until the year 1862 that an elaborate solution was given by Mr. W. S. B. Woolhouse in the volume for that year. The problem may be enunciated as follows:—"In a school of fifteen girls, a rule has been laid down that they shall walk out every day in rows of threes, but that the same two girls shall never come together twice in the same row. The rule is supposed to have been carried ont correctly during the six working days of the week, but when the time comes for their going to church together on Sunday it is found to be absolutely impossible to continue it any further. Can the rule have been carried out correctly during the six previous days?"—Other papers brought before the Society were: "On the relation between Bernoulli's numbers and the binomial coefficients," by Mr. J. Hammond. The paper, which was accompanied by a coloured diagram, showing how certain four determinants for the numbers are formed of selected coefficients, contained some interesting numerical results which follow directly from certain division formulæ given in a former paper by the same writer.—"On three-bar motion in plane space," by Mr. S. Roberts. In this communication the author determines three foci, any two of which may be taken as centres of the link movement and the nature of the linkwork in each case.—"Values of certain infinite products, with an application to the summation of the geometrical series of the *n*th order as a definite integral," by Mr. J. W. L. Glaisher, F.R.S.—"On the form of cam which, acting on a lever, shall communicate a motion such that the angular velocity ratio of the lever and cam is a given function of the angle described by the latter," by Major J. R. Campbell.

Geological Society, Nov. 3.—Mr. John Evans, V.P.R.S., president, in the chair.—Mr. Thomas Andrew, 18, Southernhay, Exeter; Mr. Harry M. Becher, White Lodge, Barnes, S.W.; Mr. Arthur Back Kitchener, F.C.S., 19, Buckingham Street, Strand, W.C.; Mr. Daniel Morris, Grammar School, Burnley; Mr. Christopher Thomas Richardson, M.D., 13, Nelson Crescent, Ramsgate; and Mr. Gustavus A. H. Thureau, Lecturer on Geology and Practical Mining, School of Mines, Sandhurst, Victoria, were elected Fellows of the Society.—On some new Macrurous Crustacea from the Kimmeridge Clay of the Sub-Wealden Boring, Sussex, and from Boulogne-sur-Mer, by Mr. Henry Woodward, F.R.S. The first species described by the author belonged to the fossorial family Thalassinidæ, six species of which belonging to four genera are now found on the British coasts. The known fossil species are from the Chalk of Maestrich, the Greensand of Bohemia and Silesia, the Chalk of Bohemia, the Greensand of Colin Glen, near Belfast, and the Upper Marine Series of Hempstead, Isle of Wight. All these are referred to the genus *Callianassa*, which also includes the species from the Kimmeridge Clay described in this paper. The fossil is seen in profile on several sections of the core, and has the enlarged hands of the fore limbs more nearly equal in size than in the living species of *Callianassa*; the carapace and segments of the abdomen are smooth, and the latter are somewhat quadrate in profile, contracted at each extremity, and not pointed, and the caudal plates are oval. For this Crustacean the author proposes the name of *Callianassa isochela*. The second species described belongs to the genus *Mecochirus*, distinguished by the great length of the fore-limbs, which is equal to that of the whole body, the oldest known species of which (*M. olifex*, Quenst.) is from the Lower Lias of Würtemberg. It was obtained, together with *Lingula ovalis*, from the Kimmeridge Clay of Boulogne, by Mr. J. E. H. Peyton, after whom the author proposes to name it *M. Peytoni*. In this species the fore-legs are very finely punctate, and measure seventy-five millims. in length. The rostrum is somewhat produced, and the carapace, which is finely granulated, measures thirty millims. in length. The antennæ are long and slender. The abdomen measures forty-five millims., and the epimeral borders of the segments are falcate. The species is intermediate in size between *M. socialis*, Mey., and *M. Pearcei*, M'Coy, which the author regards as distinct. He also refers to *M. Peytoni* a pair of fore-limbs obtained from the Sub-Wealden boring.—On a new Fossil Crab from the Tertiary of New Zealand, by Henry Woodward, F.R.S. In this paper the author described a crab obtained by Dr. Hector, F.R.S., Director of the Geological Survey of New Zealand, from the "Passage-beds" of the Ototara series in Woodpecker Bay, Brighton, on the west coast of the south island of New Zealand. The new species belongs to the genus *Harpactocarrcinus*, A. Milne-Edw., which includes six species from the Eocene of southern Europe. Its nearest ally is *H. quadrilobatus*, Desmar., but its carapace is much more tumid, especially in the branchial and gastric regions; the surface of the anterior half of the carapace is nearly smooth, and that of the posterior half finely granulated. The rostrum is short and very obtusely tricuspidate, the orbits shallow and rounded, the hepatic margin bluntly toothed, with a stronger tooth at the epibranchial angles; the divisions of the regions of the carapace faintly indicated, and there is a slightly roughened line on the sides of the gastric intumescence. The characters of the jawfeet and of the chelæ are described by the author; of the latter the right is considerably larger than the left hand. The specimen was a female. For this species the author proposed the name of *Harpactocarrcinus tumidus*. Dr. Hector explained the sequence of formations in the locality from which the above crab was derived, and stated that the Ototara series is to be regarded as Cretaceo-Tertiary, containing some fossils of decidedly Cretaceous type, such as Saurian bones and fragmentary *Inocerami*, and other forms that are associated with decidedly Mesozoic fossils in the underlying strata. On the other hand, the occurrence of Tertiary forms such as *Nautilus ziczac* (or a nearly allied form), the gigantic Penguin (*Palæeudyptes antarcticus*, Huxl.), and a Turtle, indicate a fauna not unlike that at present existing in the vicinity.—On a remarkable fossil Orthopterous Insect from the Coal-measures of Britain, by Mr. Henry Woodward, F.R.S. The author commenced by indicating the importance of the examination of the Clay-ironstone nodules of the Coal-measures, in which so many valuable fossils have been discovered, including the remarkable insect described in the present paper. The specimen displays the characters of the four wings, only two of which, however, are nearly perfect, and these measure 2¼ inches in length and 1 inch and 1¼ inch in breadth, the hind wing being the broadest. The author described in detail the characters presented by the venation of the wings, which includes three straight veins running parallel to the fore margin, the third bifurcating near the apex, a fourth much curved vein giving origin to six branches, and having at its base a triangular space, from which arise the other veins of the wing. The body appears to have been about five lines broad between the bases of the wings. In front of the wings is the prothorax in the form of two large, rounded, dilated, and veined lobes; it measures fourteen lines across and six lines in length. In front of these lobes is the head, with its eyes produced in front into a slender process three lines long. This insect is considered by the author to be most nearly related to the Mantidæ, the characters of the head and thorax especially being to some extent paralleled in the existing genus *Blepharis*. The author proposed to name the species *Lithomantis carbonarius*, and suggested that *Gryllacris* (*Corydalis*) *brongniarti* probably belongs to the same genus.—On the discovery of a Fossil Scorpion in the English Coal-measures, by Mr. H. Woodward, F.R.S. The author commenced by noticing the various European and American localities in which fossil Arachnida have been found in the Coal-measures. Hitherto no true Scorpions have been recorded from the English Coal-measures; but in 1874 the author received from Dr. D. R. Rankin a specimen from the Coal-measures near Carluke, which he regarded as the fossil abdominal segment of a Scorpion; in April last he obtained a fossil Scorpion from the Sandwell Park Colliery, and in August Mr. E. Wilson forwarded to him several specimens of similar nature in Clay-ironstone nodules from Skegby New Colliery, near Mansfield. The specimens are all very imperfect, but the author states that they most closely resemble an Indian form, which is probably *Scorpio afer*. He refers the English species provisionally to the genus *Euscorpius*, Meek and Worthen, and proposes to name it *E. anglicus*.—The Drift of Devon and Cornwall, its origin, Correlation with that of the South-east of England, and place in the Glacial Series, by Mr. Thomas Belt, F.G.S. The author described the general characters of the drift in the district under consideration, and stated that on the uplands the drift consists of undisturbed gravels and travelled boulders, which occur only in isolated remnants on the lower ranges, and that in the lowlands and valleys within 100 feet of the present level of the sea the gravels are widely spread, and show signs of sudden and tumultuous action. Between the upland and lowland gravels he considered that great denudation had taken place. He maintained that the boulders and the materials of the gravels had been distributed by floating ice, and that their presence on the summit of Dartmoor indicated that the water on which the ice floated must have extended up to 1,200 feet above the present sea-level; but he argued that this water was not that of the sea, because no old sea-beaches or remains of marine organisms are to be found in the region, although freshwater shells are preserved. He described these phenomena to the presence of a great freshwater lake, produced by the drainage of Europe being dammed back by a great glacier flowing from the north-west (Greenland) down the present bed of the Atlantic, and over the northern parts of the continent. The author discussed the characters of the superficial deposits in the southern and south-eastern counties, and indicated the points in which these seemed to bear out his hypothesis. The sequence of phenomena assumed by the author is as follows:—Accepting Mr. Tylor's notion that the actual sea-level must have been lowered during the Glacial period in consequence of the great accumulation of water in the form of ice at the poles, he seeks a point of departure at the Glacial period in the first evidence of such a lowering of the sea-level. The Weybourne sands and the marine beds of Portland Bill were deposited when the sea was at about its present level, and the Bridlington Crag probably belongs to the same period. The fossils found in these deposits show that the waters were cold. The first stage of the Glacial period is that of the older Forest-beds, and the immigration of a number of great Mammalia and of Palæolithic man indicates that the sea had retired from the British Channel and the German Ocean, leaving these islands connected with the Continent. A great river probably ran southwards through the region now submerged. The second stage is marked by the continued advance of the ice from the north, the retreat of the southern fauna and Palæolithic man, and the arrival of Arctic Mammals. The third stage saw the culmination of the Glacial period and the greatest extent of the Atlantic glacier, which reached to the coast of Europe, blocked up the English Channel, and caused the formation of an immense lake of freshwater by damming back the drainage of the whole of north-western Europe, as already indicated. In the fourth stage the Atlantic glacier began to retreat, and the sudden breaking away of the barrier of ice that blocked up the mouth of the Channel caused the tumultuous discharge of the waters of the great lake, by which the spreading of the lowland gravels was effected. To this cause the author attributes the formation of the Middle Glacial sands and gravels of Norfolk and Suffolk. During the fifth stage the ice of the German Ocean continued to retreat; but there was a temporary advance of the Atlantic glacier, which again blocked up the Channel, and produced a second great lake, which, however, did not attain so great a height as the first, and its waters were not discharged in the same tumultuous fashion. At this period the Upper Boulder-clay of Norfolk and Suffolk was formed; but the author is not convinced that this formation is represented south of the Thames except by the "Trail" of the Rev. O Fisher. In the sixth and last stage the Atlantic ice retreated as far as the north of Scotland, but the sea had not returned to its former level. The British Isles were connected with the Continent and with each other. To this the author assigns the last great Forest period, and the arrival of Neolithic man and the associated fauna from the Continent.

Astronomical Society, Nov. 12.—Prof. Adams, president, in the chair.—A valuable series of solar photographs were presented to the Society by the executors of the late Prof. Selwyn. They represent a period of rather more than eleven years, and so cover a complete cycle of sunspot frequency. The negatives are upon glass and have been taken upon a scale of four inches to the sun's diameter. The casket in which the Freedom of the City of London had been presented to the Astronomer Royal was shown to the meeting, and Sir G. B. Airy gave an account of the work that had been going on at the Observatory during the recess. Attention has been paid to the positions of the satellites of Saturn in connection with the ephemerides, which have been published by Mr. Marth in the *Monthly Notices* and *Astronomische Nachrichten*. A new eight-year Greenwich catalogue of stars is being published. Stella-spectroscopy has also been energetically followed up, and though the observations were at first somewhat discordant, latterly they have grown more consistent, and the results which have been obtained in the main verify those of Mr. Huggins as to the approach and recession of stars from and towards us in the line of sight. The Astronomer Royal remarked that Mr. Huggins had in this direction had the privilege of starting a new science, and it would be their duty at the Observatory to revise it; they intended to follow up the matter still further, but there were great difficulties still to be overcome, difficulties which no one could appreciate who had not attempted delicate work of the kind. They had also at the Observatory been applying themselves to photography, and had taken negatives of the sun with considerable regularity, though there were fewer spots to be observed now than at any former period which he could remember. Sir G. B. Airy also laid before the Society a map of the stars in the neighbourhood of Mars during its next opposition in 1877, and drew attention to the great advantages which this opposition would offer for the determination of the solar parallax.—Mr. De la Rue gave an account of the preparations that are being made both in France and Austria for the cultivation of physical astronomy. At Vienna an observatory is in the course of erection outside the city, on an area of some fifteen or seventeen acres. A central dome is being erected of 42 feet in diameter, which is to hold a 27-inch refractor, by Grubb, of Dublin.—Prof. Pritchard gave an account of the new Physical Observatory at Oxford, and of the mounting of the 12¼ inch refractor by Grubb, which has recently been bought by the University.—Lord Lindsay read a note on the progress of the reduction of his observations of the transit of Venus; and Mr. Bidder exhibited at the meeting and described an observing chair of simple and inexpensive construction.

Physical Society, Nov. 13.—Prof. Gladstone, F.R.S., president, in the chair.—The President stated that since the last meeting of the Society, Prof. Everett's important work on the Centimetre-Gramme-Second System of Units had been published by the Society. The book is based on the recommendations of a committee of the British Association, and consists of a collection of physical data concisely presented on the above system, a complete account being added of the theory of units.—Dr. Stone then read a paper on Thermopiles. He has recently been engaged in some experiments with a view to ascertain the best alloy for use in thermopiles. The thermo-electric power of a metal or alloy appears to be quite unconnected with its power for conducting heat or electricity, or with its voltaic relation to other metals, neither does it appear to have any relation to specific gravities or atomic weights. The thermopiles employed were of a form slightly modified from that employed by Pouillet in his demonstration of Ohm's law. Alloys are frequently more powerful than elementary metals, thus: 2 parts antimony and 1 part zinc have a negative power represented by 22·70, while that of antimony is 6·96 or 9·43, and of zinc is 0·2. A strange exception, however, is that of bismuth and tin, for while the power of bismuth is + 35·8, when the two metals are alloyed in the proportion of 12 to 1, the power becomes − 13·67. Dr. Stone first used a couple consisting of iron and rich German silver (that is, rich in nickel). This was characterised by great steadiness, but the electromotive force produced by moderate differences of temperature was not great. He then used Marcus's negative alloy, consisting of 12 parts antimony, 5 of zinc, and 1 of bismuth, but the crystalline nature and consequent brittleness of this mixture were found to be great objections to its practical use. It occurred to Dr. Stone that the addition of arsenic might diminish the brittleness without injuring the thermo-electric power, and on trial it was found that an alloy of zinc, antimony, and arsenic, with a little tin, formed a much less brittle mass than Marcus metal, with quite as great or greater thermo-electric power. A set of twelve couples of this alloy and German silver was exhibited. The electromotive forces of this set and of a similar one of twelve iron and German silver couples were determined by Mr. W. J. Wilson, and found to be, for one alloy and German silver couple with difference of temperature of 80° C., $\frac{1}{108}$ of a Daniell's cell. The electromotive force of one couple of the iron and German silver set was $\frac{1}{648}$ of a Daniell's cell. The ordinary method of applying heat by a trough of hot water is objectionable, for the water short-circuits some of the current. This is evident from the fact that if oil heated to the same temperature be substituted, a considerably greater deflection is obtained. Another method suggested by the author, which would tend to economy, is to allow petroleum to volatilise in the neighbourhood of one face of the pile, thus chilling it, and to ignite the mixture of air and gas so produced at the other face. Clamond's pile, consisting of iron and an alloy of zinc and antimony, was employed for some time, but although good results were obtained, the iron is liable to rust at the connections.—Dr. Guthrie remarked that in researches of this nature the main object in view was to ascertain what relation, if any, existed between the direction of the current and the amount of heat-flow. He referred to the experiment with a tangle of fine platinum wire, by which it is found that if either end of the wire be heated, a current flows towards the tangle, and this takes place however well the tangle may be annealed. Dr. Guthrie suggested that the great effect which alloying one metal slightly with another has on its position in the thermo-electric series may perhaps be connected with its change in conducting power for heat.—Mr. Walenn referred to experiments which he made some years since on thermopiles when used at high temperatures. The most powerful currents were obtained with a couple in which amalgamated copper was employed, but the power was soon lost in consequence of the volatilisation of the mercury. Subsequently he employed wires of wrought iron and German silver, and although the results were not specially remarkable at moderately high temperatures, the power became great when the connections were raised to a red heat.—Prof. Foster called attention to Matthiessen's table of the electric conductivities of metals and alloys in relation to the use of the latter in thermopiles. The fact shown by Matthiessen that the conductivities of alloys are greatly influenced by changes of temperature, will probably, he considers, be found to have some connection with their thermo-electric action. He also mentioned, as a fact which should be remembered when considering the construction of thermopiles, that the presence of minute traces of impurity completely changes the electric conductivity of a metal.

Anthropological Institute, Nov. 9.—Col. A. Lane-Fox, president, in the chair.—Major T. F. Wisden was elected a member.—Mr. Francis Galton, F.R.S., read the following papers:—"Heredity in Twins." On comparing the number of twins found among the uncles and aunts of twins with those found in similar classes of society generally, it appears that twin-bearing is hereditary, in so far that there is an excess per cent. of three individuals of twin birth in the former group. It further appears that the male and female lines contribute the twin-bearing tendency in identical proportions. The families are very large in which twins are born; even those of their parents average nearly seven persons, but the twins themselves appear neither to marry so frequently nor to be so prolific as other persons. However, the common belief that both twins are in no case fertile is quite untrue.—"A Theory of Heredity." Starting with the generally admitted view that the body consists of a multitude of organic units, each of which is to a certain degree independent of the rest, and with certain postulates which that view implicitly recognises, there exists a firm basis on which to establish a theory of heredity. By these and their necessary consequences, the object of double parentage, and therefore of sex, was first explained by the likeness and dissimilarities observed between brothers and sisters, and the still more remarkable similarities and contrasts between twins of the same sex, were then accounted for. It was argued that the germs which were selected for development into the bodily structure had very small influence in an hereditary point of view, but it was those germs that were never developed but remained latent, that were the real origin of the sexual element; by this hypothesis the almost complete non-transmission of acquired modification was explained; also the occasional fact that strongly marked characteristics in the parents were sometimes barely transmissible, and again that of certain diseases skipping alternate generations. It was further supposed, in the successive segregations and segmentations of the earliest germinal matter, that the divisions were never precise, and therefore that alien germs were ultimately included in each structure; thus latent germs of all kinds became distributed over all parts of the body. This accounted for much that Mr. Darwin's theory of Pangenesis over-accounted for, and was free from objections raised against the latter. The assumed evidence that structural changes under modified conditions of life reacted on the sexual elements was then discussed, and it was pointed out that much that had the appearance of heredity was not so in fact, but was due to changes of the sexual elements collaterally with the structural ones. A modification of Pangenesis was adopted, as a subsidiary part of the main theory, to account for the occasional and limited transmission of acquired modification. The precise character of the relationship that connects the offspring with the parents was then defined.—Mr. F. W. Rudler, F.G.S., read a report on the Department of Anthropology at the Bristol meeting of the British Association.

Institution of Civil Engineers, Nov. 9.—Mr. Thos. E. Harrison, president, in the chair.—The paper read was on the Manora Breakwater, Kurrachee, by Mr. William Henry Price.

CAMBRIDGE

Philosophical Society, Nov. 1.—Mr. Pearson read a paper on Aristotle's notion of "Right-Handedness;" and added some remarks on a theory of his own on the subject.

BOSTON

Natural History Society, May 5.—This was the Annual Meeting, when Prof. Hyatt, the Custodian, presented his report, in which he described the condition of the numerous collections belonging to the Society. The following papers were read:—On some of the habits of the Blind Crawfish (*Cambarus pellucidus*), and the reproduction of lost parts, by F. W. Putnam.—Synopsis of the Odonata of America, by Dr. H. A. Hagen.

PARIS

Academy of Sciences, Nov. 8.—M. Frémy in the chair. The following papers were read:—Discovery of two small new planets, at the Observatory of Paris, by MM. Paul and Prosper Henry, by M. Leverrier.—Memoir on measurement of the affinities in the reaction of two solutions on one another, taking as bases the electromotive forces, by M. Becquerel.—On the alcohols which accompany vinic alcohol, by M. Is. Pierre.—On the exhaustion of the soil by apple-trees, by M. Is. Pierre. He estimates that an annual supply of about 80 kilogrammes of manure would be required for a single tree, to maintain the original fertility of the ground.—Observations by M. P. Thenard on M. Pierre's communication.—M. de Lesseps presented the second volume of his work on the History of the Suez Canal.—On the separation of mixed liquids and on new maximum and minimum thermometers, by M. Duclaux. It is always possible to begin with a mixture (at a given temperature) such that on lowering the temperature very little (much less than the tenth of a degree), it divides into two layers of equal volume; *e.g.* a mixture of 15 c.c. amylic alcohol, 20 c.c. ordinary alcohol, and 32·9 c.c. water, at 20°. The thermometers on this principle are easily made, cheap, solid, and resistant to shocks and pressure, though, of course, a special mixture is required for each.—Note on the determination of cafeine, and the solubility of this substance, by M. Commaille.—On a process for separating cholesterine from fatty matters, by M. Commaille.—On the various modes of structure of eruptive rocks, studied with the microscope, by M. Michel Levy.—Researches on the inversion of cane-sugar by acids and salts, by M. Henry.—Comparison of unipolar excitations of the same sign, positive or negative: influence of increase of the current on the value of these excitations, by M. Chauveau. In medical use of electricity, he finds that to manage the current with regularity, unipolar excitation should be used with the positive pole for motor, and with the negative for sensitive, nerves.—On the anatomy and histology of Lucernaria, by M. de Korstneff.—Treatment, with sulphocarbonates, of the spot which indicated the appearance of Phylloxera at Villié-Morgon, by M. Duclaux.—On electro-capillary currents produced by mineral caustics, by M. Onimus.—On the influence of acids on coagulation of blood, by M. Oré. Neither acids nor alcohol coagulate albumen when injected directly into the circulation; and most substances insoluble in water, but which cease to be so in presence of acids and of alcohol, may be injected without causing coagulation, after being submitted to the action of these.

GENEVA

Society of Physics and Natural History, Oct. 7.—Prof. Alfred Gautier gave an account of the meteorological observations made in Labrador by the Moravian missionaries at various stations in that northern region. The first notice, published by him in June 1870 (*Archives des Sciences*, tome xxxviii. p. 132), referred to the first documents of that kind sent by the missionaries from 1778 to 1780, and published in the Phil. Trans., vols. 69 and 71; then a second series, made from 1841 to 1843, contained in the *Annales* of M. Lamont, of Munich. A new series of observations has been undertaken since 1867, by means of thermometers sent from Geneva by M. Gautier, and it has been continued more or less regularly by the missionaries. Results have been received from four stations; that of Hopedale, from 1868 to 1874; Zoar, for one year, from Sept. 1870 to Sept. 1871; that of Hebron, from Sept. 1869 to August 1870; Rama, the most northerly, from July 1872 to June 1874. Hopedale is situated in 55° 39' N. lat. The annual means of temperature in Centigrade degrees, drawn from three observations daily, made at 7 A.M., 12 noon, and 7 P.M., are as follows:—

December 1868	to	November 1869	–	3°·04
,, 1869	,,	,, 1870	–	3°·42
,, 1870	,,	,, 1871	–	2°·83
,, 1871	,,	,, 1872	–	2°·32
,, 1872	,,	,, 1873	–	3°·63

The mean of five years is thus – 3°·09. Compared with the mean of Edinburgh (in an even more northerly lat., 55° 57'), which is about 8°·4, it indicates the enormous difference existing between the temperatures of corresponding latitudes on the western coast and in the eastern regions of the North Atlantic. The mean of the seasons at Hopedale deduced from the collective observations is as follows: Winter, – 18°·0; spring, – 5°·5; summer, 9°·0; autumn, 1°·3. The minimum temperature in winter is from –26° to –36° below zero. The absolute minima observed have been – 38° on Feb. 3, 1870, and – 39° on Feb. 2, 1873; on March 1, 1874, – 35° was observed. In July and August there was not much frost, and vegetation prospered. The thermometer rose to 29° and even 30°, which it reached on July 26, 1871. The daily variations resulting from five years' observations rose in the mean to 4°·49. Its monthly maximum was 6°·6 in June 1873, and its minimum 1°·4 in November 1869. It is accidentally sometimes much more considerable. The most notable instance was on Oct. 11, 1871, when the thermometer, which indicated – 4°·2 at 7 A.M., sank at 7 P.M. to – 27°. The barometric observations made at Hopedale present inconsiderable variations. In the neighbouring districts these variations being often very sudden and very extended, it may be asked if the instruments used are in a satisfactory condition. Since the heights reached vary between 29 and 30½ English inches, it may be presumed that the tube is quite free from air? This is a point deserving a special inquiry. From the three daily observations made at the station of Zoar from September 1870 to August 1871, may be deduced a mean annual temperature of – 2°·26. Zoar is situated in about 56° of N. lat. At Hebron two daily observations at 7 A.M. and 2 P.M. during one year, from September 1869 to August 1870, give a mean of – 3°·6. The latitude is about 58° 20'. The two previous years gave an annual mean of – 4°·5, and besides former observations in 1841–2, a mean of – 5°·3. Finally, at Rama, situated in about 60° N. lat., the annual mean in 1872–3 was about – 5°·6.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—Bamboo considered as a Paper-making Material: T. Routledge (Spon).—Four Thousand Miles of African Travel: Alvan S. Southworth (Low and Marston).—Artes Africanæ: Dr. G. Schweinfurth (Low and Marston).—Journal of the Royal Agricultural Society of England. Vol. ii. Part 2 (Murray).—Notes on Forestry: C. F. Amery (Trübner).—Tenth Annual Report of the Quekett Microscopic Club.—The White Conquest: William Hepworth Dixon (Chatto and Windus).—The Potton and Wicken Phosphatic Deposits: J. J. Harris Teall, B.A., F.G.S. (Deighton, Bell, and Co.)—The Nature of Light, with a general account of Physical Optics: Dr. Eugene Lommel (H. S. King).—Science Lectures for the People, delivered in Manchester. 1st and 2nd, 3rd and 4th, 5th and 6th series (Manchester, John Heywood).—Theory of Heat: J. Clerk-Maxwell, M.A., LL.D. (Longmans).—Papers on Glacial Geology: T. Mellard Reade, C.E., F.C.S. (Liverpool Geological Society).

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