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THURSDAY, DECEMBER 18, 1873

THE TRANSIT OF VENUS EXPEDITIONS

SOME time ago we called attention to the admirable opportunity which would be afforded by the approaching Astronomical Expeditions for the observation of the Transit of Venus to investigate the Natural History of several little-known islands of the Pacific. The addition of one or two members to these expeditions could make but a comparatively trifling addition to the expense, and while the Astronomers were observing, the Naturalists would be busily employed in collecting. We are glad to be informed that at a recent meeting of the Council of the Royal Society it was determined to take action in this matter, and to advise the Government to attach a small staff of Naturalists to the two expeditions destined to observe the transit in the Island of Rodriguez and Kerguelen's Land. There can be little doubt, we presume, that the Government will readily accede to the advice thus offered to them.

Rodriguez, an outlier of the Mascarene group, is in many ways specially worthy of thorough investigation. As a general rule oceanic islands lying at a distance from the great continents are of volcanic origin. The Seychelles and the island of Rodriguez are almost the only known exceptions to this rule. Rodriguez, so far as the slight information we possess on the subject extends, is believed to be composed of granite overlaid by limestone and other recent rocks. It is, therefore, of great importance that an accurate geological examination should be made of this island, more especially as its nearest neighbours Bourbon and Mauritius follow the ordinary rule of being volcanic. A second rich field of biological research in Rodriguez will be found in the fossil remains to be met with in the caves of the limestone rocks. These have already yielded good fruit to the investigations of Mr. Edward Newton. the Colonial Secretary of Mauritius, aided by grants from the British Association. The complete skeleton of *Pezophaps solitaria*, a bird allied to the Dodo of the Mauritius—has been restored from these remains, as is well-known from the excellent memoir upon this extinct bird published by Mr. Newton and his brother, Prof. Newton of Cambridge, in the Philosophical Transactions of the Royal Society. But besides additional bones of the Solitaire, which will be welcome to many Museums, it will be desirable to become acquainted with the other animals which were the Solitaire's fellow-creatures when in existence. Some of these are also obscurely known through the exertions of the Messrs. Newton, but it cannot be doubted that ample materials of this kind are still lying hid in the caves of Rodriguez for the benefit of future explorers.

The recent Zoology and Botany of Rodriguez also merit thorough investigation in order to ascertain whether they show any parallel differences to that of its geological structure as compared with the rest of the Mascarene group of islands.

Kerguelen's Land, the second point selected for biological investigation, is also likely to give ample occupation for a naturalist who will be able to devote several months to its exploration, while the necessary preparations are being made for the observation of the great astronomical event. In 1840 Kerguelen's Land was visited by the Antarctic Expedition under Sir James Ross. The distinguished naturalist who accompanied the expedition ascertained that it contains a scanty land-flora of flowering plants, some of which belong to types elsewhere unknown, and an extraordinary profusion of marine forms of both the animal and vegetable kingdoms. Of the land-plants a good series was obtained, but as regards the marine flora and fauna much must remain to be done—especially as Sir James Ross's visit took place in mid-winter. The *Challenger* will visit Kerguelen's Land early next year in order to ascertain the best station for an Astronomical Observatory, and her excellent staff of naturalists will, without doubt, not neglect the opportunity thus given to them. But looking to the great size of the island, which measures nearly 100 miles by 50, and to what is reported of the excessive richness of the marine forms of life, there will certainly be ample occupation left for the naturalist whom it is proposed to send there along with the Transit expedition.

There is, in fact, no doubt that it would be difficult to find two spots on the earth's surface where investigation is more likely to lead to satisfactory results than in the case of these two little-known islands. Nor is the opportunity now offered of obtaining these results at a very small cost to the nation likely to recur, if now neglected. We trust, therefore, that on the part of the Government there will be no hesitation in acceding to the scheme put before them by the Council of the Royal Society.

ELLIS'S LIFE OF COUNT RUMFORD

Memoir of Sir Benjamin Thompson, Count Rumford, with Notices of his Daughter. By George E. Ellis. (Published in connection with an edition of Rumford's complete Works by the American Academy of Arts and Sciences. Boston.)

THIS biography supplies a want that has been sorely felt by all who have desired to obtain a reliable account of Count Rumford's eventful life. It is, I think, impossible to name any equally eminent man of modern times concerning whom so little was known before the publication of this work. The only preceding sources of information, Prof. Pictet's letters, Prof. Renwick's sketch in "Sparks's Library of American Biography," Cuvier's *Eloge* and the Cyclopædia biographies made up from these and each other, are most vexatiously contradictory on points of primary interest. Aided by Rumford's own correspondence, and other original and direct sources of information, Mr. Ellis's industry has at last rescued us from these perplexities.

The career of scientific notables is usually of a simple and uneventful character, but that of the poor schoolmaster of New Hampshire is sufficiently adventurous and romantic to supply materials for a sensation-novel writer.

He married early; to quote his own words—"I took a wife, or rather she took me, at 19 years of age." He describes his married life as both happy and profitable, but it lasted scarcely three years, during which he became a prominent public man and a full-blown soldier, with the rank of major at 20 years of age. The part he took in connection with the American rebellion excited popular indignation against him, led to his imprisonment, the confiscation of his property, and his subsequent flight from home shortly after the birth of his daughter. He never saw his wife again, nor did he see his daughter until 20 years afterwards, when she rejoined him in Europe.

At the age of 23, he appears in a new character upon another scene. He is now a diplomatist, presenting his first state paper to Lord George Germaine in London. He steps at once into a responsible position in the Colonial Office, and presently becomes the "Secretary of Georgia." In the meantime he is doing important scientific work, is elected Fellow of the Royal Society in 1779, when 26 years of age, and suddenly appears on board the *Victory* as a volunteer sailor under Sir Charles Hardy, experimenting with ship's guns, and writing treatises on naval signals and naval architecture. In the following year he is promoted to the office of "Under Secretary of State for the Northern Department" (Colonial).

Thirteen months after this he re-appears in military uniform as Lieut.-Colonel Thompson commanding "The King's American Dragoons," and profoundly occupied with experiments upon light artillery, &c. Before 1781 is ended, we find him on the other side of the Atlantic with his dragoons on Long Island, and fighting in the neighbourhood of Charleston at the beginning of 1782. In April we hear of him in New York, and presently find that he has returned to England promoted to the rank of full colonel, and otherwise honoured for his American services.

In the midst of all this activity and excitement he is busily engaged in scientific research chiefly upon subjects connected with gunpowder, bullets, and artillery. With his characteristic exaltation of present pursuits he is now consumed by military ardour, and, dissatisfied with his late inglorious outpost skirmishing in America, obtains appointment for active service in the defence of Jamaica against the French, but is frustrated by the temporary pacific re-action that suddenly prevails. He offers to serve in India, but the Government has become economical. Determined to fight somebody, he selects the Turks, with whom Austria is temptingly disposed to quarrel, and, having obtained the King's permission, proceeds to Vienna, with war-horse, arms, and uniform. Halting on his way he creates considerable sensation by appearing as a visitor on the garrison parade at Strasburg, displaying his handsome figure, brilliant English uniform, and his skilful management of an English blood-horse. Field-Marshal Prince Maximilian de Deux Ponts rides up to the stranger, salutes, and asks a few questions. Thompson, with the polished courtesy and tact of which he is so accomplished a master, turns this introduction to good account, secures the friendship of the Prince, who is so strongly impressed with the varied attainments of the brilliant soldier, that he presses him to pass through Munich on his way to Vienna and visit the reigning Elector of Bavaria, an uncle of the Prince.

The visit is made most successfully, and, with additional introductions, Thompson proceeds to Vienna with a ready-made continental reputation, though only a few weeks old. Here, as he says, "I owe to a beneficent Divinity that I was cured in time of that martial folly." The agent or Divinity of this reformation, was a lady, who, as he says, "formed an attachment to me, gave me wise advices, and imparted a new turn to my ideas, by presenting me in perspective other species of glory than that of conquering battles." It is proper to add, in explanation, that the lady was seventy years of age.

In the meantime the Elector of Bavaria invites Thompson to enter his service. For an English officer to do this, permission from the king was necessary. This was obtained in London, and with it the honour of knighthood, which was conferred in February 1784, with a continuance of half-pay as colonel.

Sir Benjamin Thompson proceeds immediately to Munich, and there enters upon the most remarkable part of his extraordinary career. The task which he set before himself in Bavaria was nothing less than a complete reformation and re-organisation of the army, and a general improvement of the physical and social condition of the whole nation. Invested with full powers by the Elector he sets about his work in a strictly philosophical manner. The first four years—1784 to 1788—are devoted to a cool, impartial, and systematic investigation of the social statistics and general condition of all classes, civil and military, in Bavaria. Having thus inductively collected and generalised his data, he now proceeds deductively to devise his remedies for the evils thus demonstrated. In all his efforts, from the improvement of saucepan-lids and gridirons to the moral reformation of a whole nation of human beings, he is rigidly methodical and strictly scientific, and his success follows as a direct and visible consequence of this scientific mode of proceeding.

His well-known and important researches on the Convection and general Transmission of Heat were undertaken and carried out mainly for the purpose of determining the best and most economical means of clothing the Bavarian soldiers, and the construction, warming and ventilation of their barracks. Another equally important though less known series of researches were instituted for the purpose of learning how to feed in the most economical manner the beggars, rogues, and vagabonds, whose sustenance and reformation he had projected.

His success in reorganising both the men and materials of the army was marvellous. It was in the course of his work in erecting cannon foundries and remodelling the Bavarian artillery that his celebrated demonstration of the immateriality of Heat was suggested.

It may safely be affirmed that the foundation of the present military system and of the recent military successes of Germany was laid by Benjamin Thompson in Bavaria. He tells us that the fundamental principles upon which he proceeded were "to unite the interest of the soldier with the interests of civil society, and to render the military force, even in times of peace, subservient to the public good;" and further, "that to establish a respectable standing military force which should do the least possible harm to the population, morals, manufactures, and agriculture of the country, it was necessary *to make soldiers citizens, and citizens soldiers.*"

Besides the important technical reforms of discipline, arms, barracks, quarters, military instruction, &c., which he carried out, "schools were established in all the regiments, for the instruction of the soldiers in reading, writing, and arithmetic, and into these schools not only the soldiers and their children, but also the children of the neighbouring citizens and peasants were admitted gratis." Military schools of industry were also established where the soldiers learned useful trades; thus the military clothing was spun, woven, and made up by the soldiers themselves; roads and other public works were made and erected, and the men were permitted to hire themselves out in garrison towns. Besides this the soldiers were used as industrial missionaries for the introduction of improvements in agriculture, manufactures, &c. The potato, until then almost unknown in Bavaria, was thus introduced by the aid of Thompson's military gardens or model farms. One of these gardens still remains, viz. the well-known "English Garden" at Munich.

Still more remarkable was his success in radically curing the overwhelming curse of Bavaria, which was infested with hordes of beggars and vagabonds that had defied every previous effort of suppression or diminution Here again the same strictly philosophical method of proceeding was adopted. Human materials and motives were handled precisely as we manipulate the physical materials and forces of the laboratory, and the results were similarly definite, reliable, and successful. The scientific social reformer not only cleared the country of its rogues, vagabonds, and beggars, but made their industry pay all the expenses of their own feeding, housing, and clothing, besides those of the industrial and general education of themselves and their children. In addition to all this they made clothing for the military police who took them into custody, and earned a handsome net profit in hard cash.

It is not surprising that such success should have earned for him a long list of Bavarian honours and titles which need not be here recounted, and that he should now appear as "Count of the Holy Roman Empire and Order of the White Eagle," or, as better known to us, in the title of his own choice, "The Count of Rumford." Neither need we be surprised that his health should fail, and that in spite of repose and change of scene we next find him lying dangerously ill at Naples.

On his recovery he returns to England, and while busily engaged there in literary and scientific work, is suddenly recalled to Munich, which now has the Austrians at its gates, and is simultaneously threatened by the French. Matters become so serious that the Elector saves himself by flight, only eight days after Rumford's arrival; but before leaving the monarch hands over to the philosopher the command-in-chief of the army, and the practical dictatorship of the capital. During the three months of this supreme command Rumford succeeds in overawing and checkmating both French and Austrians, and saving the city, after which the Elector returns.

This is the climax of the great philosopher's career, and now we find him a second time stricken by dangerous illness. On recovering he returns to London, founds the Royal Institution, publishes his essays, and then leaves England for the last time to reside in Paris, where he marries the "Goddess of Reason," Madame Lavoisier.

Here the curtain falls upon all his greatness, for though but fifty-two years of age, the brilliant career of the Count of Rumford is ended, and the subsequent scenes of his life display a miserable contrast with all that preceded them.

His biographers are evidently puzzled by what follows, and painfully seek apologies for his matrimonial squabbles, his general irritability, his morose seclusion, and the small results of the fussy labours of the last ten years of his life. My own theory is that the illness at Munich —where he describes himself as being "sick in bed, worn out by intense application, and dying, as everybody thought, a martyr to the cause to which I had devoted myself"—was followed by chronic and permanent cerebral disease, and that the gradually developing change of character which he displayed from the date of his return to England in 1798, until his death in 1814, was but a natural symptom of this growing malady.

Present space does not permit me to state in detail the evidence upon which I base this conclusion, but I cannot conclude without protesting against the explanation of Cuvier, who in his *Eloge* states that "It would appear as if, while he had been rendering all these services to his fellow-men, he had no real love or regard for them. It would appear as if the vile passions which he had observed in the miserable objects which he had committed to his care, or those other passions, not less vile, which his success and fame had excited among his rivals, had embittered him towards human nature." Cuvier, if I am right, only knew the diseased wreck of the brilliant, courteous, and even fascinating "soldier, philosopher, and statesman," and I suspect that the unjust oblivion of his merits which so speedily followed his death, was largely due to the bad impression made, not only upon the French Academicians, but also upon his Royal Institution associates, by the moral obliquities and eccentricities due to a diseased brain.

The main interest of the career of this wonderful man appears to me to lie in this, that it affords a magnificent demonstration of the practical value of scientific training, and the methodical application of scientific processes to the business of life. I have long maiatained that every father who is able and willing to qualify his son to attain a high degree of success either as a man of business, a soldier, a sailor, a lawyer, a statesman, or in any other responsible department of life, should primarily place him in a laboratory where he will not merely learn the elements of science, but be well trained in carrying out original physical research, such training being the best of all known means of affording that systematic discipline of the intellectual and moral powers upon which all practical success in life depends. The story of Count Rumford's life, and the lesson it teaches, afford most valuable evidence in support of this conclusion, and cannot fail powerfully to enforce it.

This subject is specially important at the present moment, particularly to those Englishmen whose minds are still infested with the shallow foolishness that leads them to believe that scientific men are dreamy theorists, and disqualified for practical business. Let them follow in detail the practical triumphs of this experimental philosopher, and ask themselves candidly whether such success could have been possible had he been trained in the mere word-exalting study of the Greek and Latin classics, instead of the practical school of experimental research.

W. MATTIEU WILLIAMS

GARRETT'S FISHES OF THE PACIFIC

Andrew Garrett's Fische der Südsee beschrieben ünd redigirt. Von Albert C. L. G. Günther, Heft i. (Hamburg: L. Friederichsen & Co., 1873.)

THE house of Hr. Cesar Godeffroy & Co. of Hamburg have for several years employed scientific collectors in various parts of the Pacific to prepare and send home specimens of natural history. These have been stored up at Hamburg, in what is now a well-known scientific institution, the "Museum Godeffroy," under the care of an active superintendent, whose services have been engaged to take charge of and arrange the various objects thus accumulated. But not content with thus bringing the rarities of the Pacific within the grasp of European naturalists, Herr Godeffroy has obtained the assistance of some of the best known workers in Science for examination of these materials. The extensive collections of birds made for him by Dr. Edward Gräffe were submitted to the well-known ornithologists Drs. Finsch and Hartlaub of Bremen, and formed the basis of their excellent work on the "Birds of Central Polynesia," published a few years since. For the working out of the Polynesian Fishes, of which we believe, Herr Godeffroy's collection is still more complete, the co-operation of Dr. Günther of our National Museum, the most distinguished of living ichthyologists, has been obtained, and the book now before us contains the first-fruits of Dr. Günther's labours.

The brilliant colours which adorn many of the Polynesian fishes have been well known to travellers in those regions since the days of Cook, and have been frequently described in lively terms. Unfortunately, however, these colours entirely disappear in fishes preserved in spirit after the ordinary fashion, so that their beauty can only be appreciated by visitors to the distant seas which they inhabit. In order to exhibit these colours in the present work, Herr Godeffroy has acquired a large series of drawings, taken from living specimens, by Mr. Andrew Garrett, who has been many years resident in the Sandwich and Society Islands, and in other parts of Polynesia. Under these circumstances we may well anticipate the production of a first-rate work, more especially as the services of the unrivalled lithographic artist, Mr. G. H. Ford, have been secured to put the drawings on the stones.

Dr. Günther commences his work in systematic order with the Serranidæ, of which numerous brightly coloured forms inhabit the various Archipelagoes of the Pacific. Twenty splendid plates illustrate the letterpress, and it is only wonderful how they can be produced at so small a cost. Nine similar parts will complete the work, which bids fair to become one of the most perfect icthyological monographs ever issued.

OUR BOOK SHELF

Manual of Comparative Anatomy and Physiology. By S. M. Bradley, F.R.C.S. Second Edition. (Manchester: Cornish; London: Simpkin, Marshall and Co.)

ENCOURAGED by the success of an earlier and much smaller edition of this work, the author has entirely rewritten the new one. In so doing, we think that he could not have made a greater mistake, as the small size of the original precluded the introduction of detail with which he is not acquainted, and so prevented his exposing his ignorance to the world at large. The impression which remains after the perusal of a few pages is, that the author, after reading rapidly through some one of the standard text-books on Zoology, wrote down his impressions as far as his memory served him. Faults of omission are not uncommon in text-books, especially when they are written by those who are not practically acquainted with their subject, but faults of commission are, fortunately, much less common. In the work before us there are several of the former, and they cannot all be laid down to want of space; for in the case of the Myriapoda, respecting the peculiarities of the main divisions of which the position of the legs is not referred to, two-thirds of the page on which they should have been found is left blank before the commencement of the following chapter. The faults of commission are so numerous that they admit of easy classification. There are those of sheer carelessness from inattentive reading, otherwise, how is it that we are told that the Dugong has six cervical vertebræ, and that the *Tragulinæ*, or Musk Deer (!) have all the tarsal bones anchylosed. Others arise from a want of power to realise the meaning of the ordinary descriptions of well-known anatomical facts, as when it is indicated that the ventricles of the Crocodile's heart are not completely separated, and the marsupium, or pouch of the female Kangaroo in the male is everted, and supports the penis. Absolute and inexcusable errors it is difficult to explain, but among such we are told that the Nummulites are Cephalopoda; the Marsipobranchii have more than one nasal sac; that in the Lepidosiren the nasal canals are not open at both ends, and the vertebræ are ossified; and that in the Bear the clavicles are more developed than in other Carnivora, when they are in reality absent altogether. Peculiarities found in one division are omitted with regard to them, and referred to others entirely different, as when it is stated that among the Marsupialia "each oviduct in the female leads into a perfectly distinct uterus, which opens into a separate vagina, which is also the passage of the urine," and that in the male the vasa deferentia "open into a cloaca common to the urinary and generative secretions." These remarks apply to the Monotremata well enough, how is it they are omitted in speaking of them, and stated of their allies, which in these respects are quite differently constructed. We rarely remember to have seen a work so carelessly undertaken, and by so incompetent an author.

Seventeenth Half-Yearly-Report of the Marlborough College Natural History Society for the Half-Year ending Midsummer, 1873. (Marlborough: Perkins.)

ALTHOUGH the tone of the Preface to this Report is not quite so desponding as that of the previous one, still it contains a good deal of complaint. It seems to be the rule, for which we cannot see any reason, that members on entering the fifth form resign their membership. Is it because their schoolwork occupies all their time? or is it considered beneath the dignity of a fifth-form boy to belong to such a society? Probably no satisfactory reason could be assigned for the practice, therefore we hope it may not be continued. Another discouragement to the society has been the difficulty of getting papers except from a very few, who, after a time, "struck work," because they "felt that others ought to help in keeping up the interest of the meetings." We think the few workers would have been more likely to attain this end had they continued to prepare and read papers amid all discouragements; by this means, we think, they would be more likely "encourager les autres." We see no reason why the reading of papers should not be combined with the exhibition of objects and with discussions. Is not the Marlborough College Society too sensitive? From the reports of the field-work done and the collections made, it seems to possess a few admirable workers, who possess energy, knowledge, and earnestness enough to keep any such society from collapsing. The Botanical list is a model one. The papers in the Report are,—"Heraldry," by Mr. F. E. Hulme, F.L.S.; "On the Perception of the Unseen," by Mr. G. F. Rodwell; "A Walk across the Karst," by the Rev. J. Sowerby; and "The Luschari (Heilige) Berg in Carinthia," by the same gentleman.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Prof. Agassiz

THE sad intelligence received in London this morning of the death of Prof. Agassiz adds another illustrious name to the long roll of victims to the insidious demon, "over-work." May I ask you to give room in your next issue to the following passage from a letter (probably one of the last he penned) received from Prof. Agassiz only last week, which may be interesting to his many sorrowing friends on this side the Atlantic, as attesting indirectly to the cause of his death, viz., excess of mental and physical exertion. P. DE M. GREY EGERTON

Athenæum Club, Dec. 16

"Museum of Comparative Zoology,
"Cambridge, Mass., Nov. 26, 1873

"A feeling of despondency comes over me when I see how long a time has elapsed since I received your last letter, which at the time I meant to answer immediately. With returning health, I have found the most frightful amount of neglected work to bring up to date, with the addition of a new institution to organise. I have given myself up to the task with all the energy of which I am capable, and have made a splendid success of the Anderson School, which cannot fail henceforth to have a powerful influence upon the progress of Science in the United States. But this has driven out everything else, and I should have neglected even the Museum had not a constant appeal to my attention arisen from the close connection in which the Anderson School stands to the Museum, of which it is, as it were, the educational branch. So School and Museum have made gigantic strides side by side; but I am down again. At least I feel unable to exert myself as usual, and such a feeling in the beginning of the working season is disheartening. When I last wrote I had strong hopes of an easy summer with my family, and confidently expected to be able to pass the greater part of the winter in Europe, and to have prepared the volume on Selachians of the 'Poissons Fossiles' for a new edition, or rather an English work on the subject. Now that hope is gone; the immense accessions to our Museum make even the progress of the Coal Fishes from Iowa slow and almost hopeless. With 22 assistants and 14 sub-assistants in the Museum, I have my hands full with administrative duties and responsibilities, and science and friends suffer.

"Ever truly your friend,
"(Signed) L. AGASSIZ"

Experiments on Frogs

WILL you grant me the space in your journal for a few words called forth by Mr. Lewes's letter in your number of December 4, on "Sensation in the Spinal Cord"?

In that letter the writer describes some experiments on frogs of such excessive cruelty that I cannot refrain from entering a protest against the principle which justifies such actions.

The right to perform such actions as vivisection, &c., in the cause of Science, has often before been questioned; but the present case—a case in which the infliction of pain is not an unavoidable *attendant* on the experiments, but the very essence or object of them, and the slowness and prolongation of agony a necessary part—stirs and revolts the whole mind, and brings the question again prominently to the front.

The question then is—are either the possible or probable benefits to a portion of mankind, or the advancement of Science for its own sake, sufficient reasons for the infliction of intense suffering on our fellow-animals? Of course much may be urged in favour of vivisection. It may be said that without its assistance Science, and especially the science of medicine, could never have advanced to the point it has now reached; and mankind urges that the good of mankind is of such paramount importance that that of all other animals must be subordinated to it unconditionally, and consequently that the smallest good to mankind balances the greatest evil to other animals.

To many this would be considered an amply sufficient reason for answering the question in the affirmative, but at least it should be remembered at what tremendous cost to one portion of creation these benefits to another portion are purchased.

As time and Science advance it is becoming more recognised that other animals have their rights as well as men; and perhaps it may some day be found that the right which mankind assumes to himself of supremacy over his fellow-animals (including the right to inflict deliberate torture, for whatever purpose) is, after all, but the right of the strongest or most powerful.

It seems to me so shocking that such things should be written of and read with indifference, and without evoking one word of protest on the other side, that on this ground alone, *i.e.*, that the assumption of the right to inflict torture may not pass quite unchallenged, I venture to beg for the insertion of this letter.

Dec. 8 X.

Proposed Alterations in the Medical Curriculum

IN a recent number of NATURE, remarks are made in regard to the present Medical Curriculum, more especially in connection with the proposal of Prof. Huxley to alter the Curriculum for medical graduation in the University of Aberdeen. His object is to remove the subjects of Botany and Natural History from that Curriculum, and to put them in the category of a preliminary examination, without any compulsory attendance upon lectures. Such a proposal if carried into effect would tend in no small degree to limit the medical student's acquirements in the biological sciences, as he will not be required to take full scientific courses on these subjects. The tendency of such a system will be to encourage what is commonly called "cram," inasmuch as there will be no guarantee for methodical practical instruction under a qualified teacher.

While it may be true that those who take the diplomas of the medical corporations are not called upon to attend courses of lectures on these subjects, and rarely undergo an examination on them, the case is quite different with those students who aspire to university degrees. The latter look not merely for a license to practise, but desire also a university honour. An important distinction at the present day, between the licentiates of colleges and the graduates of universities, is that the latter are expected to have a higher literary and scientific knowledge. In place of reducing the qualifications for degrees, so as to compete with colleges, we ought to keep up the standard, and send forth medical men who are not only well fitted for the practical duties of the profession, but who can also occupy a prominent position in the scientific world. In accomplishing this object we should arrange the curriculum in such a way as to put the study of the sciences in its proper place. The student ought to commence the study of botany and natural history in summer, before entering upon anatomy, surgery, and other purely medical subjects. This is now to a large extent carried out in the University of Edinburgh, and by so doing a three months' course of scientific study is added to the curriculum. The student might be encouraged to take his science examination at an early period of his curriculum, say at the end of his first year of study. The training which these studies give to the mind of the young medical student, is most important. They call forth his powers of observation and diagnosis; they present to him the principles of classification, and they enlarge his views of anatomy and physiology. In primary schools of the present day we frequently find that the elements of botany and zoology constitute a part of the teaching, and most properly so. But this is not enough for the graduate in medicine. He must supplement this by going through the higher University Curriculum.

The commissioners for visiting the Universities of Scotland, remark in their report "that it is desirable that graduates in medicine should have that degree of literary and scientific attainment which will prevent them when mingling as they must do with mankind, in the exercise of their profession, from being looked upon with contempt ; or from committing errors in conversation and in writing, for which others would be despised ; because even upon the supposition that they have high professional acquisitions, the law of association will operate, and the conclusion will be drawn that much confidence cannot be placed in them." The value of university training was strongly insisted on by the late Prof. Edward Forbes, when speaking of the relation which scientific studies bear to medicine. The following are his remarks :—"It is the training of the mind in correct methods of observation that gives the Natural History Sciences so much value as instruments for preparation in professional education. Not unfrequently do we hear the short-sighted and narrow-minded ask—what is the use of zoology or botany or geology to the physician and surgeon? what have they to do with beasts or plants or stones? Is not their work among men healing the sick? Of what use save as remedies, are the creeping things, or the grass that grows upon the earth, or the minerals in the rock? Vain and stupid questions all—yet they are sometimes put by persons who profess to promote the spread of education. They want something, but the best of them mistake the end for the means. The best want knowledge, but have not learnt that the mind must be trained ere it is prepared to gather and digest knowledge. They want science, but science turns mouldy and unwholesome in our unprepared mind. They forget or do not know that education consists chiefly in training, not in informing.

"We must counteract the natural tendency of purely professional studies—the tendency to limit the range of mental vision. We can do this most beneficially through the collateral sciences, which are sufficiently different to give them a wider sphere of action. It is from this point of view that we should regard the natural history sciences as branches of medical education. For my part," continues Forbes, "after much intercourse with medical men who had studied at many seats of professional education, some collegiate, some exclusively professional, I have no hesitation in saying that, as a rule, the former had the intellectual advantage. There are noble and notable exceptions old and young, but the rule is true in the main. The man who has studied at a seat of learning, university or college, has a wider range of sympathies, a more philosophical tone of mind and a higher estimate of the objects of intellectual ambition, than his fellow-practitioner who, from his youth upwards, has concentr ated his thoughts upon the contractedly professional subjects of an hospital school. I will not believe that the practitioner of medicine, any more than the clergyman, or the lawyer, or the soldier or merchant, is wiser, or better able to treat the offices of his calling, because his mind takes no note of subjects beyond the range of his professional pursuit. It is a great pleasure, both to patient and neighbourhood, to find in our doctor an enlightened friend, one who, whilst he does his duty ably and kindly, has a sympathy and an acquaintance with science, literature, and art."

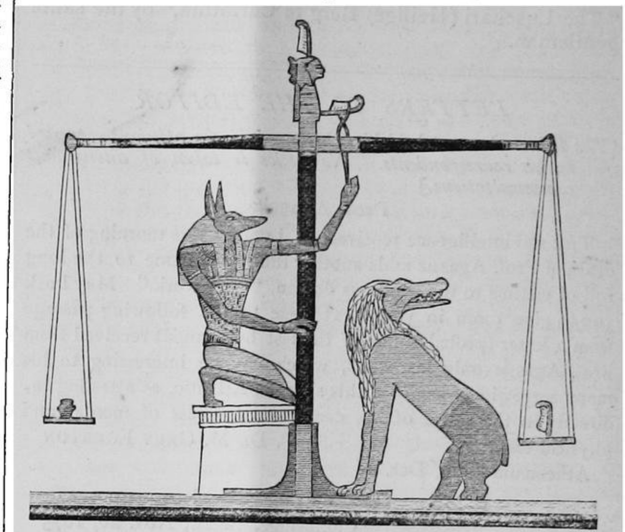
In Scotland a university is not merely a board authorised to examine students and grant degrees, it is an educational institution, intended to exercise a surveillance over the studies of youth, to train their minds for the proper acquisition of knowledge, and to direct their energies in such a way as to insure that mental culture which will fit them for all the duties of life. We speak of our University in Scotland as our *Alma Mater* because she acts the part of a mother to her *alumni*, educating them and superintending their progress in liberal studies.

It appears to me that a great injury would be inflicted on the character of our medical degrees if the required curriculum did not embrace the natural sciences To study these properly something more than books is required. There must be practical training under an able teacher, examination of living objects both with the naked eye and with the microscope, and a certified course of study. I am sure that everyone, in Scotland at all events, who desires to make graduation in medicine a University honour will aid in keeping up a scientific curriculum under qualified teachers.

Edinburgh University JOHN H. BALFOUR

Ancient Egyptian Balances

I HAVE to thank Mr. Rodwell for calling my attention, in NATURE, vol. ix. p. 8, to the curious representation of an equal-armed Egyptian balance in a papyrus, now in the British Museum. This papyrus, which is perhaps the most beautiful in the whole collection, all the colours and lines being as bright and distinct as when originally painted, has been shown to me by Dr. Birch, who also informed me where I could procure a photograph of it, being one of a series of photographs from the collection at the British Museum, taken by S. Thompson, and published by Mansell and Co., 2, Percy Street. By Mr. Mansell's permission the following drawing has been made.



From an ancient Egyptian papyrus in the British Museum, of Hennefer, superintendent of the cattle of Seti I., 19th Dynasty, about 1350 B.C., representing the "Ritual of the dead." The heart of the deceased is being weighed in an equal-armed balance, and found lighter than a feather. In the papyrus, the weighing is being made in the Hall of perfect Justice, in presence of Osyris.

It may be seen that what Mr. Rodwell mentions as a sliding weight on one side of the beam, appears rather to be a loop or ribbon for limiting the oscillation of the beam. In the original papyrus the middle and both ends of the beam, as well as the lower part of the column, are coloured to represent polished brass, whilst the other parts of the balance are dark, as if of bronze. It should be observed that the balance beam has box-ends for suspending the pans. Judging from the height of the human figures, the length of the balance beam represented is about six feet, and the height of the column of the balance is nearly the same. Several similar, though rougher, representations of weighing the heart of the deceased may be seen in the papyrus drawing on the staircase leading from the Egyptian sculpture room to the upper Egyptian room in the British Museum.

H. W. CHISHOLM

Stalagmitic Deposits

IN a former number of NATURE (vol. viii. p. 462), Mr. A. R. Wallace, in reviewing Sir Charles Lyell's last edition of the "Antiquity of Man," makes use of the rate of deposits of stalagmite as data for ascertaining the age of animal remains which are found buried in caves. It is evident that the variations of rate will render unreliable data for arriving at correct conclusions; still, calculations based thereon may be of service.

Some thirty years ago I procured a piece of lime deposit from a lead mine at Boltsburn, in the county of Durham ; it measured about 18 in. in length, 10 in. in breadth, and fully $\frac{3}{4}$ in. thick ; it was compact and crystalline, and showed distinct facets of crystals on its surface, over which the water was running. I had indisputable evidence that the deposit had taken place in fifteen years. The water, from which it was produced, issued from an adit driven in the Little limestone, which is about 9 ft. thick. After leaving the adit, the water ran down the perpendicular side of a rise, for some fathoms, on to some rock *débris*, which was lying on the bottom of a hopper, whence it proceeded from the upper part of the hopper mouth, then perpendicularly down over two narrowish wood deals, which were set on edge, and put across the mouth of the hopper to retain the worked materials. It was from off these deals that I obtained the specimen above described. On its back side the forms of the deals were well defined; on the front one the crystals were best developed where the stream was most active.

In accordance with the above rate of increase of deposit, namely, ⅗ in. in fifteen years, 5 in. would require 100 years, 4 ft. 2 in. 1,000, and 41 ft. 8 in. 10,000 years. The data given to arrive at these results may be relied on as being accurate. In the case now related, the rate of increase of deposit was likely to continue tolerably uniform; as the surface water could have no appreciable influence in augmenting or lessening the flow from the adit.

Boltsburn, Nov. 26 JOHN CURRY

Shooting-stars in the Red Sea

ON my way to India, in November 1872, I witnessed in the Red Sea the splendid phenomenon of a star-drift, a note about which may be of interest, in comparison with the observations at the same time in Europe.

November 24, at 8 P.M., about 600 miles to the south of Suez, I first saw a series of shooting-stars falling from about 70° W.N.W., but not in such a quantity that my attention was much attracted; I only made a note about it in my diary.

In the night of the 25th–26th I noticed nothing particular, but in that of the 26th–27th again many shooting-stars were to be seen.

But in the night of the 27th–28th, about 100 miles to the west of Aden, the phenomenon reached its height. Through the whole night many thousands of shooting-stars were falling from every quarter of the heavens, and in all directions. It was impossible for me to count the average number falling in one minute, although I tried several times to do so, because the eye could not be everywhere, and the shooting-stars did not come from one point only. I sat the whole night on deck, to witness this sublime phenomenon of nature, which certainly was far more splendid here in the tropics than in Europe, on account of the generally greater brightness of the stars in these latitudes.

A. B. MEYER

Cuckoos

IN vol. v. p. 383 of NATURE, you were so good as to publish a note of mine, in which I tried to describe exactly all that took place when I saw a young cuckoo throw a young pipit out of the nest.

I am much flattered to find that Mr. Gould has thought my note fit to be transferred to the introduction of his magnificent "Birds of Great Britain," and a rough sketch of mine worthy to be made the foundation of one of his large coloured plates. As, however, I have always tried in my drawings of facts in natural history to express neither more nor less than what I saw, I think it right to say that I am not the authority for many of the details in the large plate.

None of us saw the parent pipit looking on while the young cuckoo behaved so naughtily; we saw only two young pipits besides the young cuckoo, and no egg-shells. The young cuckoo was absolutely naked and blind, the young pipits partly fledged and bright eyed.

One curious point I tried to call attention to in my former note in these words:—"The nest . . . was below a heather-bush on the declivity of a low abrupt bank . . . The most singular thing of all was the direct purpose with which the *blind* little monster made for the *open* side of the nest, the only part where it could throw its burthen down the bank." This peculiarity my rough sketch could not, and Mr. Gould's plate does not, express.

J. H. B.

ASTRONOMICAL ALMANACS*

VII.—*Continuation of the History of the "Nautical Almanac."*

UNTIL towards the end of the life of Maskelyne, its founder, the *Nautical Almanac* had the approbation of the English, and knew how to deserve the praise of foreigners; it was, according to Lalande, the most perfect ephemeris that had ever existed.* But, in 1808, death deprived Maskelyne, who was then about 76 years of age, of his pupil and industrious *collaborateur*, R. Hitchins, upon whom he had depended for ten years for the most important part of his work, the verification of the calculations, and who was during that time the real editor of the *Nautical Almanac*. The advanced age of Maskelyne no longer permitting him to undertake any active occupation, the work passed into irresponsible hands, the calculations fell into great confusion, and "while astronomy advanced, the *Nautical Almanac* remained stationary, and even retrograded."† Maskelyne died shortly afterwards, in 1811, and Brown of Tiedeswill (Derbyshire), was appointed to succeed him. The new director did not improve the *Nautical Almanac*, and English mariners and astronomers complained loudly; a reform was necessary. The Board of Longitude being incompetent to improve the work of which it had charge, Government abolished that body in 1818, by advice of the Admiralty, to which the publication of the work was entrusted, and which replaced the former body (which numbered sixteen members) by another much less numerous.

This new Board of Longitude was ingeniously formed; it was composed of a Resident Committee "of three persons well versed in mathematics, astronomy, and navigation, nominated by Government," to which was added, a Commission of the Royal Society, consisting of the president and three members, charged to support it, and, if need be, to control it. The members of the resident committee had to live in London, or its neighbourhood, and to lend their aid to the Commissioners of the Royal Society for the scientific questions within the domain of the Commission. They received a salary of 100*l.*, and the secretary of the committee, who was charged with the publication of the *Nautical Almanac*, a salary of 500*l.* Captain Kater, Dr. Wollaston, and Dr. Young were appointed resident members, and the latter, the secretary of the committee, had the editorship of the *Nautical Almanac.*

Young did much to improve the work, to restore to it the reputation for accuracy which Maskelyne had given it, and to render it capable of satisfying the constantly increasing wants of navigation. Thus, he introduced into the *Almanac*, in 1822, the apparent position, for every ten days, of twenty-four fundamental stars, which number was increased to sixty in 1827; mariners had thus constantly at their command the exact position of their reference points. Moreover, it is to him that we owe the publication of the elements by means of which we can predict occultations of stars by the moon, phenomena so useful to astronomers on an expedition, and to sailors whose ships are in a foreign harbour.

But these improvements were by no means the only ones which English astronomers and mariners demanded; as it was, the *Nautical Almanac* satisfied neither the one nor the other of these; sailors stood in need of the ephemerides and planetary distances of Schumacher, and astronomers of the supplement to these ephemerides.‡ Moreover, it often happened that these ephemerides appeared too late to be of any service to mariners who were setting out on a long voyage. Thus Young was exposed to criticism, very just, no doubt, but sometimes extremely violent. The result was an excessively sharp controversy, which, although sustained by most of the English

* Continued from p. 70.

* "Correspondance astronomique francaise," of Baron de Zach, vol. iv. pp. 87, *et seq.*

† Sir James South's Address to the Royal Astronomical Society, February 12, 1830.

‡ The first of these ephemerides was due to the Baron de Zach, and Rear-Admiral Hövernörn caused them to be adopted by the Danish Governor in 1800. The Director of Copenhagen Observatory, Thomas Bugge, was then entrusted with their editorship; they were continued by Schumacher, and a little later were published, partly at the expense of the British Government. They gave the position of the planets Venus, Mars, Jupiter, and Saturn for every day in the year, and their distances from the moon every three hours.

astronomers, was concentrated in two eminent men, especially remarkable for their intense love of astronomy. The one was Sir James South, a rich landowner, who carried his love of astronomy so far as to devote the greater part of his income to the construction and maintenance of his observatory of South Villa. The other was Francis Baily, who, by dint of his persevering efforts, got the Board of Longitude to publish, in 1825, the original observations of T. Mayer, and who was, at a later period, the promoter of the measures taken for the publication of the numerous observations of Lalande. Behind these was the Royal Astronomical Society.

The end to be attained was as clear as it was legitimate; it was sought to make the astronomical part of the *Nautical Almanac* more complete and make it answer all wants. Young and the other members of the Board of Longitude opposed to these attacks a resistance unhappily too energetic. But public opinion was formed, and the first satisfaction it obtained was the suppression of the Board of Longitude in 1828. Young was then in very bad health; indeed, it was seen that he could not live long, and it was not thought right to sadden his last days by taking from him the direction of the *Nautical Almanac*.

In the meanwhile, an event of the greatest importance took place on the Continent, which rendered reforms more urgent than ever. We speak of the radical change which the illustrious Encke had introduced into the "Jahrbuch" of Berlin, a change which embodied the greater part of the desiderata named long before by Baily and Sir James South, and for which was awarded to its author the gold medal of the Astronomical Society. To comprehend this completely, it is necessary to go a little further back, and learn the history of the "Jahrbuch" from the point where we left it.

VIII.—*Continuation of the History of the "Jahrbuch"*

After the death of Lambert, Bode was entrusted with the care of the *Jahrbuch* under the direction of the Berlin Academy. But soon the difficulties which resulted from the publication of this special work, under the orders of a numerous assembly, "in which everybody had the right of criticism, but in which no one had the effective responsibility," difficulties which, during the life of Lambert, had not had time to manifest themselves, became such that in 1783 the Academy of Sciences of Berlin decided of its own accord to give up the direction of the *Jahrbuch*, and to leave to that member who had the actual editorship the complete responsibility as well as the honour of that publication. It was, besides, by the advice of the celebrated Lagrange that Bode was consulted. The latter then became editor of the *Jahrbuch*, which was now published only "with the approval of the Academy."

This astronomer, however, followed religiously the plan traced by Lambert, not attempting any essential modification in the form of the *Jahrbuch*. But in attempting to render perfect the ephemerides, he sought chiefly to collect in the second part the most remarkable astronomical results of Germany and foreign countries. For this purpose he entered into correspondence with nearly all the astronomers of Europe, and the *Jahrbuch* of Berlin soon attained, in this respect, such a renown that, "from this time," says Lalande in his "Bibliographie Astronomique," "all astronomers are obliged to know German, for this work cannot be dispensed with." In the ephemerides the only modification of any importance on the plan of Lambert which Bode allowed himself during the whole of his editorship, was the addition of a table giving the corrections which it was necessary to make on the times of the rising and setting of the heavenly bodies at Berlin to obtain the times of the same phenomena in other latitudes.

During this time, however, astronomy had progressed. The beautiful memoirs of Bessel on the determination of the apparent positions of the stars, the improvement made on instruments, the convenience of the methods by which Bessel had learnt to correct and revise the results of these, had increased the wants of astronomers. On the other hand, the theory of the planetary movement had made immense advances, and the planetary system itself had been enriched by four telescopic planets—Ceres (Piazzi, Jan. 1, 1801), Pallas (Olbers, March 28, 1802), Juno (Harding, Sept. 1, 1804), and Vesta (Olbers, March 29, 1807). All presented the same peculiarity, that of revolving between Mars and Jupiter. It became necessary then to publish the ephemerides of these new planets, in order that astronomers might be able to observe them.

But Bode, who held for nearly half a century the astronomical sceptre of Europe, had then reached an advanced age, when the mind does not take easily to reforms.*

Bode died at Berlin, Nov. 23, 1826. J. F. Encke, then astronomer of the Observatory of Seeberg, near Gotha, Saxony, was called to the direction of the Observatory of Berlin and of the *Jahrbuch*.†

From the first volume which he published (*Jahrbuch* for 1830, May 1828), he realised all the reforms that German astronomers demanded. What then were those reforms universally called for?

IX.—*Programme of Reforms*

If we wish to understand them, it is enough to recall to mind that for a maritime people, ephemerides such as the *Nautical Almanac* and the *Connaissance des Temps* have a double purpose: to be serviceable to mariners and travellers, and also to astronomers, that is to say, to observatories.

At the very outset, it was evidently very useful to all that all the data of the work should be connected with the same kind of time, instead of giving for some the mean time, and for others the true time. And as astronomical tables are necessarily arranged on mean time, as on the other hand it is the most convenient for all the uses of navigation, it was good to take this mean time as the only time of the tables. It was, however, necessary to make an exception for the co-ordinates of the sun at the moment of his passage on the meridian, which, very evidently, ought to be calculated for the apparent noon or the true noon. Besides, from the purely astronomical point of view, it was evidently convenient to calculate the places of the sun, of the moon, and of the planets, with all possible precision, so that the comparison of the observations with the tables might serve to amend the latter. It was necessary then to calculate to the 100th of a second the co-ordinates expressed in time, and to the 10th those expressed in arc. On the other hand, it was necessary to give, for every day in the year, at mean noon, the geocentric (AR, and D), and heliocentric co-ordinates of all the principal planets, and to publish in advance ephemerides of the telescopic planets near their opposition, an epoch favourable for their observation.

Again, the observation of the eclipses of the satellites of Jupiter being one of the best means of determining the longitude of a station, it was evidently of importance that

* Johann Elhert Bode was born at Hamburg on Jan. 19, 1747. He studied under the guidance of his father, who kept a boarding-school, and at first intended him for a teacher. Mathematics, and particularly astronomy, were at an early age his favourite studies. He made his first astronomical observations in a granary, by means of a telescope which he had himself made; at 18 years he knew how to calculate, with considerable precision, eclipses and the course of the planets. Some time after, Dr. Bush, with whom chance made him acquainted, lent him his books and instruments; the vocation for which he was originally destined was from that time abandoned. In 1768 he published his treatise on Astronomy, "Die Anleitung zur Kenntniss des gestirnten Himmels," which had an immense success; shortly after he was made *pensionnaire* of the Berlin Academy. His most important astronomical work is his "Uranography," containing in 20 charts a list of 17,240 stars, double stars, nebulæ, &c.; *i.e.* 12,000 more than in the ancient charts.

† Encke was born at Hamburg, Sept. 23, 1791. Son of a protestant pastor, he studied under the celebrated Gauss at Göttingen; in 1814 he was appointed by B. de Lindenau, Minister of State of Saxony, director of the Observatory of Seeberg.

the tables of these satellites should be brought to a high degree of perfection; and as, according to the opinion of the most distinguished mathematicians, the observation of all the phenomena which are presented by one of these satellites in superior or inferior conjunction is the best means of determining certain elements of the theory of the satellites of Jupiter, it was useful to give in the collection of ephemerides not only the epochs of the eclipses, but also those of the contact of the shadow of the satellite with the planet. Tables for the observation of the satellites at the time of their maximum elongation would also be very desirable.

From the mariners' point of view, for whom the moon is the principal heavenly body, the positions of the moon calculated for noon and midnight of every day would be insufficient on account of the considerable proper movement of our satellite. To obtain the longitude of a place by means of the observation of the passage across the meridian of one of the limbs, there would be required an excessively laborious calculation; the use of that method, however convenient, was then illusory. It was necessary to give the right ascension and the declination for every hour of the day, for the purpose of avoiding the employment of second differences except in cases where very great precision was sought for.

Then, when accurate tables of the movements of the planets were obtained, it was useful to add to the distances of the moon from the sun and from the stars, the distances of that body from the principal planets, the observation of which is more convenient and more certain than that of its distances from the stars.

But it was necessary to consider not only astronomers in observatories and sailors on board their ships, it was useful to enable astronomers on an expedition, and sailors when in a foreign harbour, and also geographers, to obtain the geographical co-ordinates of their station with ease and accuracy. From this point of view the method known as that of the Lunar Culminations holds the first rank, a method to which a beautiful work by Nicolaï * gave a capital importance. The learned director of the Observatory of Mannheim showed with what facility the observations of the passage of the moon combined with those of a certain number of stars, called "stars of the moon," bordering on its parallel, and passing the meridian a little before or a little after (half-an-hour at the most), could give, sufficiently approximately, the difference of the longitudes of two places, even with a meridian instrument which was not perfect. On the other hand, Bessel and Hansen had given simple methods for calculating the horary movement of the moon. To apply this method of lunar culminations, it was then necessary to choose "stars of the moon," and to publish their positions every year, day by day, at the same time as those of the moon at the moment of its passing the meridian. This addition had, moreover, this advantage, that by indicating by an asterisk the stars comprehended between 4° and 14° of declination, the observers of the two hemispheres would have the elements most useful for improving continuously (*d'une façon continue*) the value of the lunar parallax. The phenomenon of the occultation of the stars of the moon offers, besides, an excellent means of determining longitudes. It was then important thus to calculate in advance and to publish all the elements likely to serve for predicting all the occultations in a given place, for the purpose of rendering the employment of this method easy to the navigator.

Finally it was indispensable, as well for the astronomical operations of observatories as for those connected with an astronomical or a geodetic expedition, that the collection of ephemerides should contain, for epochs sufficiently close to permit calculation for intermediate dates by simple proportion, the apparent positions of a very large number of stars of the greatest magnitude, and distributed both in the north and south hemispheres. It was useful, moreover, to join to this catalogue the values for very close epochs of the constants of Bessel, which enable one to pass from the mean position of a star at the commencement of the year to its apparent position on any day whatever.

For the principal circumpolars, α and δ Ursæ Minoris, the importance of which is so great in determining the various constants of a meridian instrument, and whose apparent positions vary much more rapidly than those of stars at a distance from the pole,—the apparent positions ought to be given every day.

Such is, with the exception of a few unimportant details, the list of reforms which the general opinion of astronomers demanded in England and Germany.

(*To be continued.*)

* "Uber die Methode, längen durch Rectascensions-Differenzen gewählten Vergleichsterne vom Monde zu bestimmen" (*Astronomische Nachrichten* for 1823 and 1824.)

ON THE SECONDARY WAVES IN THE SPHYGMOGRAPH TRACE

In a letter printed in this journal a short time ago (vol. viii. p. 464), Dr. Galabin refers to a paper which has been since published in the *Journal of Anatomy and Physiology* (No. XII. p. 1), for a fuller account of his views as to the theory of the pulse, of which we gave a short notice and criticism in a former number (vol. viii. p. 330). This second and more detailed description calls for further remark, especially as the author has found reason somewhat to modify his opinion on one important point.

As is well known, the sphygmograph trace of a pulse beat (see Fig. 1) consists of a primary rapid rise, followed by a more gradual fall, broken by a considerable undulation, termed the dicrotic wave, which varies in its distance from the next primary rise according to the rapidity of the pulse. Between the primary and the dicrotic rises in the trace, the descending curve is sometimes interrupted by another small undulation termed the "tidal" wave, by Mr. Mahomed, though the name *predicrotic* is better, as it does not involve any theoretical conceptions. It is the development in the trace of these predicrotic and dicrotic waves that Dr. Galabin discusses and his explanation of the former is the following.—The separation of the primary and tidal (predicrotic) waves is due to an oscillation in the Sphygmograph, caused by the inertia of the instrument. In some cases the lever may be separated slightly from the knife-edge on which it rests, but generally the oscillation takes place in the instrument as a whole, and it may be followed by others in a descending series. With reference to this interpretation, it may be first remarked that it seems almost impossible that the whole sphygmograph should acquire a momentum in each pulsation, for it should be so adjusted on the arm that no part except the tip of the spring is in any way in contact with the artery, and when such is the case it is difficult to conceive of any shock being communicated to the whole. Again, any sudden upward impulse given to the instrument itself would be attended with a descent in the trace, for as the lever is only attached at one end, and there only on points, its pen would be slow to participate in the general movement of the framework, and would not rise so rapidly as the recording paper. The momentum acquired by the lever is a different thing. Marey and Sanderson have both shown that the primary rise in the trace may be attended with a sudden sharp-pointed wave, in the production of which the lever leaves the knife-edge on which it rests, returning to it after a very short excursion. *To prevent the excessive development of this imperfection* Marey has employed a small secondary spring to depress the lever; this spring Dr.

Galabin persists in not employing, because he thinks—though the evidence he brings forward on the subject is extremely small—that it increases the number of minor vibratory undulations. Nothing of the kind, however, is the case. Nearly all properly-taken tracings from the pulse in health present, if there is a secondary spring employed, no percussion wave at all; and when it is present the true predicrotic wave is quite independent, as may be seen in Fig. 2, which is from a powerful, healthy pulse of 44 a minute, in which the rise *a* is the percussion, *b* the primary, *c* the predicrotic, and *d* the dicrotic wave. This true predicrotic wave varies in development with

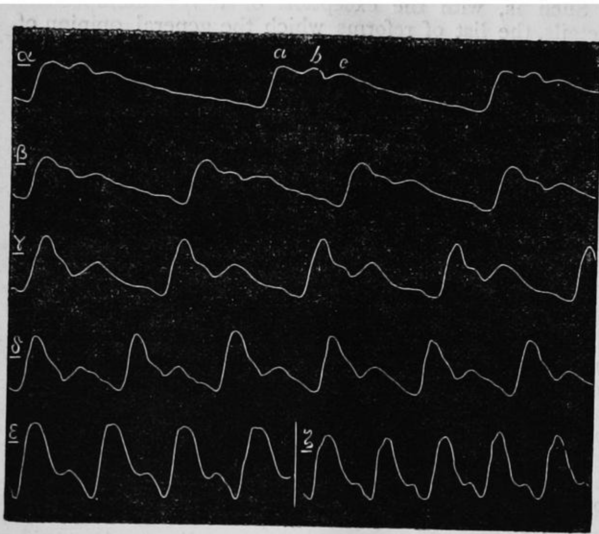


FIG. 1.—Sphygmograph tracings of healthy pulses, drawn to one scale, with rates between 44 and 170 a minute. They read from left to right.

different pulse rates, being much more conspicuous in very slow pulses, and entirely absent in very quick ones, in which last a slight percussion wave is frequently found (see Fig. 1). Dr. Sanderson has previously described these two waves as co-existing, and he is undoubtedly right, as any who have had any considerable experience in Sphygmography in health will agree. It is Dr. Galabin who is in error, and it is but little compliment to other workers in the same field even to suppose that they have been sufficiently simple-minded to study and describe as physiological phenomena, instrumental errors so uncomplicated in origin and so readily comprehended. The

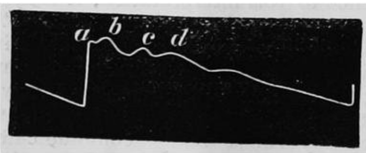


FIG. 2.—A tracing of a healthy pulse beating 44 a minute.

chief argument he brings forward in favour of his explanation is that by placing a weight on the lever at different parts, and so altering its moment of inertia, the length of the predicrotic wave is varied. That the percussion wave which is developed when no secondary spring is employed is so affected, no one will doubt, because the resistance of the pen is less significant when the lever is heavy than when it is light, and therefore the wave is of shorter duration when it is weighted. This wave, however, is even then of such considerable length that it has not ceased before the true predicrotic wave has commenced, and it therefore disguises the true nature of the trace. It is, therefore, only when the secondary spring is employed that a proper trace can be obtained; because then only is it possible to see the full extent of the true predicrotic wave, uncomplicated by the superposition of the extraneous percussion wave. The latter does not appear as an extra element of the curve, but entirely disguises its true nature, on account of its being developed quite independently, when the lever is no longer in connection with the rest of the instrument, and therefore unaffected by whatever change may be occurring in the artery.

The cause of this predicrotic wave, which Marey gives of the similar one that appears in the hæmadromometer trace (Fig. 3, β) though considered by Dr. Galabin scarcely worthy of refutation, is supported by a large number of facts, especially by the hæmadromometer trace itself (Fig. 3, *a*, β). Its commencing in the radial artery as well as the carotid, at the moment of closure of the aortic valve, is also strongly in favour of the supposition that it is of shock origin; and that a shock may be transmitted through a column of fluid, which Dr. Galabin and some others seem to doubt, can be easily proved by suddenly closing an ordinary tap through which a large volume of water is passing, whereupon several oscillations of the retained liquid occur, producing a series of blows against the tap and perhaps the side of the tube, which are heard without difficulty.

The hæmadromometer trace (Fig. 3) shows also how completely the dicrotic wave is the result of the closure of the aortic valve, as Dr. Galabin also thought

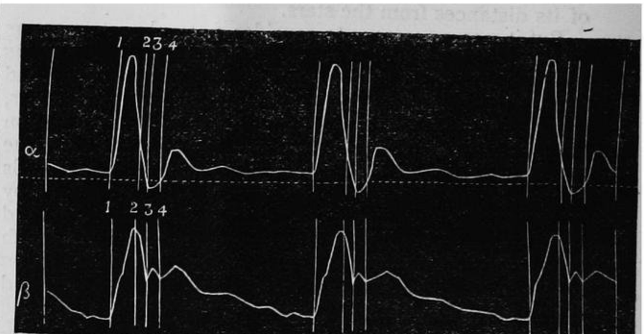


FIG. 3.—Hæmadromograph trace rom the carotid. *a*, Curve of direction and force of blood current, all above the dotted line indicating an onward and all below a heartward stream. β, Simultaneous sphygmograph trace.

in his earlier paper; but in his second he attributes it to the oscillatory result of the inertia of the arterial walls, and the lateral momentum acquired by the blood. The mass of the arterial walls, and the lateral movement of the blood during distension are so slight, that neither are in any way competent to explain a movement so constant and so considerable as the dicrotic wave, especially when one so much more reasonable is to be obtained as the result of the valve closure. At all events no theory can be considered at all satisfactory which does not explain, in one way or another, the hæmadromometer trace, which is one of the foundations of arterial dynamics, and has been verified in all its details by Dr. Lortet of Lyons. Neither Dr. Galabin's theory, nor that of Mr. Mahomed, can be said in any way to take cognizance of the facts which it discloses, and they are incapable of doing so, therefore they must be considered inaccurate. Both these authors complicate their results by arguing from the analogy of a schema or model of the circulation constructed with elastic tubes; the arteries, however, are not simple elastic tubes, but tubes cut in elastic solids, being surrounded on all sides by yielding tissues, and they are not therefore comparable with tubes experimented on in air, and will not allow of comparative deductions being drawn from them.* A. H. G.

* The blocks for Figs. I and III. are kindly lent by Prof. Humphry.

POLARISATION OF LIGHT

I.

LIGHT is said to be polarised when it presents certain peculiarities, hereafter to be described, which it is not generally found to possess. These peculiarities, although very varied in their manifestations, have one feature in common, viz. that they cannot be detected by the unassisted eye; consequently, special instrumental means are required for their investigation.

FIG 1.

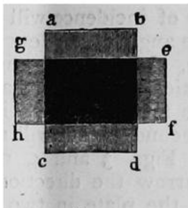


FIG. 2

The origin and meaning of the term polarisation will be better understood when some of the phenomena have been witnessed or described, than beforehand, and I therefore postpone, for the present, an explanation of it.

The subject of polarisation may be approached by either of two roads, the experimental or the theoretical. The theoretical method, which proceeds upon the principles of the Wave Theory of Light, is remarkably complete and explicit; so much so that it not only connects together many very diversified phenomena, but even, in some cases, has suggested actual prediction. But inasmuch as the theory without experimental facts would be little better than a study of harmony without practical music, it will be best to begin with experiment.

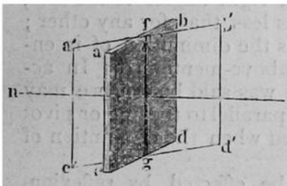


FIG. 3.

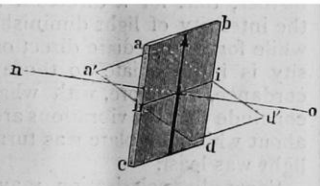


FIG. 4.

It was stated above that certain instrumental means were requisite for detecting polarisation. Now there are various processes, some occurring in the ordinary course of natural phenomena, others due to instrumental appliances, whereby a ray of light may be brought into the condition in question, "or polarised." And it is a fact both curious in itself and important in its applications, that any one of these processes (not necessarily the same as that used for polarising) may be used also as a means of examining whether the ray be in that condition or not. This latter process is called "analysation." When two instruments, whether of the same or of different kinds are used, they are called respectively the "polariser" and the "analyser;" and the two together are included under the general name of "polariscope."

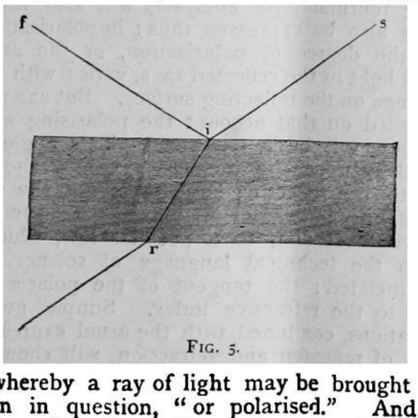


FIG. 5.

The four principal processes by means of which a ray of light may be polarised are, reflexion, ordinary refraction, double refraction, and scattering by small particles. These methods will be considered in order; but before doing so, it will be convenient to describe the phenomena of polarisation as exhibited by some instrument tolerably simple in its action and of easy manipulation. For such a purpose a plate of crystal called tourmalin will perhaps serve better than any other to begin with.

Tourmalin is a crystal of which there are several varieties, differing only in colour. Very dark specimens generally answer the purpose well, excepting that it is difficult to cut them thin enough to transmit much light. Red, brown, or green specimens are usually employed; the blue are for the most part optically unsuitable. Some white, or nearly white, specimens are very good, and may be cut into thicker plates without loss of light.

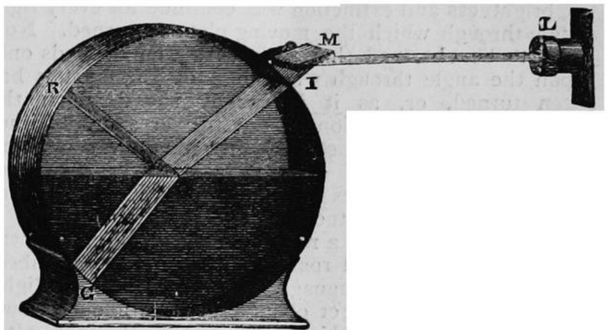


FIG. 6

If we take a plate of tourmalin cut parallel to a particular direction within the crystal called the optic axis (the nature and properties of which will be more particularly explained hereafter), and interpose it in the path of a beam of light at right angles to the direction of the beam, the only effect perceptible to the unassisted eye will be a slight colouring of the light after transmission, in consequence of the natural tint of the particular piece of crystal. But if we examine the transmitted beam by a second similar plate of tourmalin placed parallel to the former, the following effects will be observed. When the two plates are similarly placed, *i.e.* as if they formed one and the same block of crystal, or as it is technically expressed, with their optic axes parallel, we shall perceive only, as before, the colouring of the light due to the tints of the two plates. But if either of the plates be then turned round in its own plane, so as always to

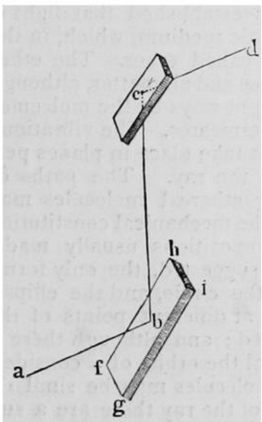


FIG. 7.

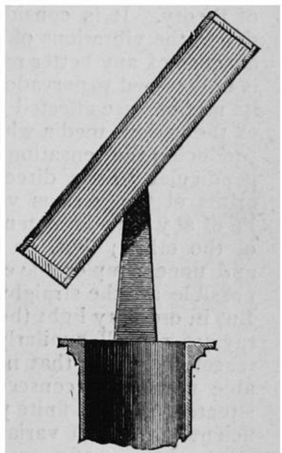


FIG. 8.

remain perpendicular to the beam, the light will be observed to fade gradually, until, when the moving plate has been turned through a right angle, the light becomes completely extinguished. If the turning be continued beyond the right angle, the light will begin to revive, and when a second right angle has been completed, the light will be as bright as at the outset. In Figs. 1 and 2 a, b, c, d, e, f, g, h represent the two plates; in Fig. 1 the two plates are supposed to be in the first position; in Fig. 2 the plate e, f, g, h has been turned through a right angle. Of the parts which overlap, the shading in Fig. 1 represents the deepened colour due to the double thickness of the crystal; in Fig. 2 it indicates the complete extinction of the light. The same alternation of brightness and extinction will continue for every right angle through which the moving plate is turned. Now it is to be observed that this alternation depends only upon the angle through which one of the crystals has been turned, or, as it is usually stated, upon the relative angular position of the two crystals. Either of them may be turned, and in either direction, and the same sequence of effect will always be produced. But if the pair of plates be turned round bodily together no change in the brightness of the light will be made. It follows, therefore, that a ray of ordinary light possesses the same properties all round, or as it may be described, in more technical language, a ray of ordinary light, is symmetrical in respect of its properties about its own direction. On the other hand a ray of light, after traversing a plate of tourmalin has properties similar, it is true, on sides diametrically opposite to one another, but dissimilar on intermediate sides or directions; the properties in question vary in fact from one angular direction to another, and pass through their phases or an entire period in every angle of 18 degrees. This directional character of the properties of the ray, on account of its analogy (rather loose, perhaps) to the directional character of a magnet or an electric current, suggested the idea of polarity, and hence the condition in which the ray was found to be was called polarisation.

Having so far anticipated the regular order of things on the experimental side of the subject, it will perhaps be worth while to make a similar anticipation on the side of theory. It is considered as established that light is due to the vibrations of an elastic medium, which, in the absence of any better name, is called ether. The ether is understood to pervade all space and all matter, although its motions are affected in different ways by the molecules of the various media which it permeates. The vibrations producing the sensation of light take place in planes perpendicular to the direction of the ray. The paths or orbits of the various vibrating ethereal molecules may be of any form consistent with the mechanical constitution of the ether; but, on the suppositions usually made, and none simpler have been suggested, the only forms possible are the straight line, the circle, and the ellipse. But in ordinary light the orbits at different points of the ray are not all similarly situated; and although there is reason to believe that in general the orbits of a considerable number of consecutive molecules may be similarly situated, yet in a finite portion of the ray there are a sufficient number of variations of situation to prevent any preponderance of average direction.

This being assumed, the process of polarisation is understood to be the bringing of all the orbits throughout the entire ray into similar positions. And in the case of the tourmalin plate the orbits are all reduced to straight lines, which consequently lie in one and the same plane. For this reason the polarisation produced by tourmalin, as well as by most other crystals, is called rectilinear, or more commonly, plane polarisation. This property of tourmalin may also be expressed by saying that it permits only rectilinear vibrations parallel to a particular direction determined by its own internal structure to traverse it.

Adopting this view of polarisation as affected by a plate of tourmalin, it would be interesting to ascertain the exact direction of the vibrations. And a simple experiment will go far to satisfy us on that point. The argument, as now stated at least, is perhaps based upon general considerations rather than upon strict mechanical proof; but the experimental evidence is so strong that it should not be denied a place here. Suppose for a moment that the tourmalin be so placed that the direction of vibration lies either in or perpendicular to the plane of incidence (that is, the plane containing the incident ray, and a perpendicular to the surface on which it falls at the point of incidence); then it is natural to expect that vibrations executed in the plane of incidence will be far more affected by a change in the angle of incidence than those perpendicular to that plane. In fact the angle between the direction of the vibrations and the surface upon which they impinge, will in the first case vary with the angle of incidence; but in the second case it will remain unchanged.

In Figs. 3 and 4, n, o represents the ray of light; the arrow the direction of vibration, a, b, c, d, a′, b′, c′, d′, the plate in two positions, turned in the first instance about the direction of vibration, in the second about a line perpendicular to it.

Dismissing, then, the former supposition, and supposing that nothing whatever is known about the direction of vibration; then, if all possible directions be taken in succession as pivots about which to tilt or turn the second tourmalin, it will be found that for one direction the intensity of the light diminishes more rapidly with an increase of tilting (or, what is the same thing, with an increase of the angle of incidence) than for any other. And further, that for a direction at right angles to the first, the intensity of light diminishes less than for any other; while for intermediate directions the diminution of intensity is intermediate to those above-mentioned. In accordance, therefore, with what was said before, we may conclude that the vibrations are parallel to the line or pivot about which the plate was turned when the diminution of light was least.

Secondly, polarisation may be effected by reflexion. If light reflected from the surface of almost any, except metallic, bodies be examined with a plate of tourmalin, it will in general be found to show traces of polarisation: that is to say, if the plate be caused to revolve in its own plane, and the reflected rays be viewed through it, then in certain positions of the plate, the reflected light will appear less bright than in others. If the angle at which the original rays fall upon the reflecting surface be varied, it will be found that the amount of alteration in brightness of the light seen through the revolving tourmalin (or analyser) will also vary. This fact may also be expressed thus: in polarisation by reflexion, the degree of polarisation, or the amount of polarised light in the reflected rays, varies with the angle of incidence on the reflecting surface. But at a particular angle, called on that account the polarising angle, the polarisation will be a maximum. This angle (usually measured between the incident ray and the perpendicular to the reflecting surface) is not the same for all substances; in fact it varies with their refractive power according to a peculiar law, which, when stated in the technical language of science, may be thus enunciated: the tangent of the polarising angle is equal to the refractive index. Simple geometrical considerations, combined with the usual expressions for the laws of reflexion and refraction, will show that this relation between the polarising angle and the refractive index may be also expressed in the following way: If light be incident at the polarising angle, the reflected and refracted rays will be at right angles to one another.

In Fig. 5, s, i represents the incident, i, f the reflected, and i, r the refracted ray. Then s, i will be incident at the polarising angle when the angle s, i, r is a right angle.

An apparatus devised by Prof. Tyndall for experimentally demonstrating the laws of reflexion and refraction is admirably adapted for verifying this law. The following description is quoted from his Lectures on Light :—"A shallow circular vessel R I G (Fig. 6) with a glass face, half filled with water rendered barely turbid by the admixture of a little milk or the precipitation of a little mastic, is placed upon its edge with its glass face vertical. By means of a small plane reflector M, and through a slit I in the hoop surrounding the vessel, a beam of light is admitted in any required direction." If a little smoke be thrown into the space above the water, the paths of the incident, the reflected, and the refracted beams will all be visible. If then the direction of the incident beam be so adjusted that the reflected and the refracted beams are at right angles to one another, and a Nicol's prism be interposed in the path of the incident beam, it will be found that by bringing the vibrations alternately into and perpendicular to the plane of incidence we shall alternately cut off the reflected and the refracted ray. Thus much for the verification of the law. But not only so, if we take different fluids and for each of them in succession adjust the incident beam in the same manner, we shall only have to read off the angle of incidence in order to ascertain the polarising angle of the fluid under examination.

The polarising angle for glass is 54° 35', water.

Thus, in Fig. 7, let a, b be the incident, and b, c the reflected ray at the first plate; b, c the incident, and c, d the reflected ray at the second plate; then the ray will be polarised more or less according to the angle of incidence, at b, and will be analysed at c.

But in accordance with the principle stated above, viz. that any process which will serve for polarising, will serve also for analysing, we may replace the analysing tourmalin by a second plate of glass (or whatever substance has been used for the first reflexion) placed parallel to the first, and in such a position as to receive the reflected ray; and if the second plate be then turned round the ray reflected from the first plate b c, as an axis, it will be found that at two positions of rotation (first when the plates are parallel and secondly when one of them has been turned through 180°) the light reflected from the second plate is brightest, and at two positions at right angles to the former the reflected ray is least bright. The degree of dimness at the two positions last mentioned will depend upon the accuracy with which the reflecting plates have been adjusted to the polarising angle; and when this has been completely effected, the light will be altogether extinguished.

Suppose now that the reflecting substance be, as in the case of glass, transparent. Then it will not be surprising if, when the reflected ray is polarised, the refracted ray should also exhibit traces of polarisation. And in fact every ray of ordinary light incident upon a transparent plate is partly reflected and partly refracted; the reflected ray is partially polarised, and so also is the refracted ray. This being so, if, instead of a single plate, we use a series of plates placed one behind the other, each plate will give rise to a series of reflected rays, due to successive internal reflections. The sum of all these will give the intensity and the amount of polarisation of the total reflected light. The phenomenon of these reflexions is therefore rather complicated; and the modifications due to the additional plates do not materially alter the proportion of polarised to unpolarised light. It is, however, otherwise with the refracted rays. The rays transmitted by the first plate enter the second in a state of partial polarisation, and by a second transmission undergo a further degree of polarisation. If this process be continued by having a sufficient number of plates, the ray finally emergent may have any degree of polarisation required.* And it is worthy of remark that, in proportion as the rays become more and more polarised, so does a less and less quantity of light become reflected from the surfaces of the plates; and consequently, except in so far as light is absorbed by actual transmission through the substance of the plates, the emergent ray suffers less and less diminution of intensity by each additional plate. So that when a certain number has been attained the intensity received by the eye or on a screen is practically unaffected by increasing their number.

Fig. 8 is a general representation of such a pile of plates viewed edge-ways. The plates are secured in a brass frame, and the whole supported on a stand.

W. SPOTTISWOODE

(*To be continued.*)

* Plates of the thinnest description are the best; two or three give good effects, but if the surfaces lie parallel and the glass be highly transparent the number may be advantageously increased to 10, or even 12.

THE ROYAL SOCIETY

THE following extracts from the Minutes of the Council of the Royal Society under the dates given, may be interesting to some of our readers :—

Jan. 26, 1860.—The President having brought under the consideration of the Council the present scale of remuneration of the Secretaries, it was resolved :—"That a Committee be appointed to inquire into the matter and report thereon to the Council; the Committee to consist of the President and the Treasurer, with Mr. Barlow, Mr. Bell, and Dr. Farr."

Feb. 23, 1860.—The President presented the following Report from the Committee appointed on January 26 to consider the question of the remuneration of the Secretaries.

"Your Committee beg to Report to the Council that, in performing the task which was imposed upon them, they have inquired into the duties of the Secretaries at various times, the gratuities which have been awarded to them, and the financial condition of the Society.

"They have been favoured with valuable information and opinions by former Officers of the Royal Society,—Sir John Herschel, Mr. Brande, Dr. Roget, and Sir John Lubbock.

"Previous to the year 1720 no regular salaries were assigned to the Secretaries, but it was customary to present them from time to time with sums varying from 10*l.* to 20*l.* under the name of 'Gratuities.'

"In 1720, on the motion of the President, Sir Isaac Newton, the Council directed that 50*l.* should be paid to each of the two Secretaries annually. In 1732 this amount was increased to 60*l.*, and in 1760 to 70*l.* 10*s.* In November 1799, on the motion of the President, Sir Joseph Banks, the amount of the salaries was reconsidered by the Council, and raised to *One Hundred Guineas* to each Secretary, at which amount they have remained from that time to the present.

"The office of 'Foreign Secretary' originated in a legacy of 500*l.* bequeathed to the Society in 1719 by Mr. Robert Keck, for the express purpose of remunerating a person for carrying on foreign correspondence. In 1720 the first Foreign Secretary was appointed, with a salary of 20*l.* a year, which sum has been paid, without increase, from that time to the present.

"It is the concurrent opinion of all who have the best means of knowing, that since the gratuities were last fixed in 1799 the business of the Society and the duties of the Secretaries have largely increased. The increase of Fellows and the larger income of the Society have enabled it to extend its operations. In the ten years 1790 to 1799, 319 papers were communicated to the Society; and in the ten years 1850 to to 1859, the number of such papers was 672. Some of the communications are short notices for publication in the Proceedings, and it is impossible to determine precisely in what ratio the work has increased; but your Committee are disposed to believe that it is represented approximately by the above figures.

The Secretaries now edit the 'Transactions' and the 'Proceedings' which are found so useful by the Fellows, and this latter duty has added considerably to their labour.

"The current revenue of the Society may be set down at about 3,514*l.* of which 1,150*l.* are derived from rents and dividends, and 517*l.* from the Stevenson bequest. The latter sum, it is known, will increase as lives fall in. The annual subscriptions amount to 1,126*l.*; the entry fees, estimated on an average of eleven years, will be about 170*l.*; the compositions 360*l.*; the Transactions will yield 276*l.*; making the aggregate revenue under these heads 1,932*l.* Your Committee see no reason to believe that these sources of income are likely to fail.

"The current annual expenditure may be stated at about 2,839*l.*; namely, 1,177*l.* on printing; 764*l.* on gratuities, salaries and wages; 187*l.* on books and binding; 511*l.* on house expenses; 200*l.* on Catalogue of Periodicals. These items necessarily fluctuate, and the printing bill last year exceeded considerably the above amount; but the amount just stated for printing is estimated from an average of the last eleven years. The income of the Society has thus for some years exceeded the expenditure by about 675*l.*

"Looking at the duties which now devolve upon the Secretaries, of regularly attending Meetings, reading papers, editing the 'Transactions,' preparing the 'Proceedings' for publication, and other work,—looking also at the remuneration which it is found desirable to give gentlemen who discharge less onerous duties merely as editors of literary works in the present day,—your Committee are of opinion that the Council will be acting quite in conformity with the sound principles which were laid down in Sir Isaac Newton's presidency, and have been acted on since, by increasing the gratuity to each of the two Secretaries. As the result of the inquiries made by your Committee, they would suggest that the addition should be 95*l.*, raising each gratuity from 105*l.* to 200*l.* This would involve an increase of 190*l.* in the expenditure.

"The relations of the Society with foreign countries may be largely extended, and your Committee are of opinion that to accomplish this object 80*l.* may be advantageously added to the 20*l.* now voted making the annual gratuity of the Foreign Secretary 100*l.*

"The total augmentation of the expenditure under this arrangement would be 270*l.* leaving a probable annual surplus of 400*l.* to be devoted to the numerous purposes which fall naturally within the scope of the Society's inquiries.

"Your Committee are of the opinion that the offices efficiently discharged will still be to a great extent honorary; and that so long as the Society itself is so fortunate as to have able, industrious, and eminent men as its Secretaries it will be still largely in their debt.

"Should the finances of the Society, through any unforeseen circumstance, require it, there would not, your Committee apprehend, be any difficulty in again revising the scale of gratuities which may be awarded."

This Report having been read, it was, on the motion of the Treasurer, seconded by Sir R. Murchison,

"Resolved—That the recommendation of the Committee respecting the honorarium to be given to the two principal Secretaries be adopted."

June 20, 1872.—On the motion of Dr. Sharpey, [pursuant to notice given, seconded by Mr. Spottiswoode—

"Resolved—That the following mode of procedure be adopted in the nomination of Fellows to be recommended to the Society for election as Council and Officers.

"1. The subject of the new Council shall be taken into consideration at a meeting of Council to be held on the last Thursday of October; and with the summons for that meeting there shall be transmitted a list of the members of the existing Council, with the number of their attendances at meetings up to that date; also a list of the Fellows of the Society, with an indication of those who have at any time served on the Council, and the dates of their service.

"2. At this meeting the names of those members of the existing Council who retire at the ensuing anniversary shall be determined. Thereafter each member present shall hand to one of the secretaries a list of not exceeding ten Fellows whom he proposes for the new Council, of whom five shall not have already served on the Council. Members not able to be present may send in similar lists previous to the meeting. The several lists of names so proposed shall then be read out by the secretary.

"3. Before the next following meeting, the president and officers shall prepare a list of twenty-one names for consideration by the Council, which list shall include ten names selected from those proposed at the previous meeting, or other names, if required to make up that number. The list so prepared, together with a statement of the names proposed and the number of votes given for each, shall be sent out confidentially with the summons for the ensuing meeting, at which meeting the names to be finally recommended shall be balloted for. In taking the ballot, a copy of the list prepared by the officers, with such alterations as he may see fit to make therein, shall be delivered by each member of the Council present and voting, and the names found to have the majority of votes shall form the list to be recommended to the Society.

"The President and Council shall then nominate by ballot, out of the proposed Council, the persons whom they recommend to the Society for election to the offices of President, Treasurer, Principal Secretaries, and Foreign Secretary for the ensuing year."

NOTES

THE present year is already remarkable for the number of eminent scientific men who have gone over to the majority: and now, just a its close, one of the most eminent in his own sphere has taken his departure. A telegram dated New York, December 14, announces the death of Prof. Louis J. R. Agassiz, in his 67th year, he having been born in Switzerland in 1807. We shall content ourselves with the bare announcement at present, hoping to be able to give, next week, a memoir of the great naturalist. Meantime we would draw the attention of our readers to the interesting letter from Agassiz in our correspondence column, sent us by Sir Philip de Malpas Grey-Egerton, Bart.

A MEETING, with Sir William Armstrong as chairman, was held at Newcastle last Thursday, to consider the question of a memorial to the late Mr. Albany Hancock. It was unanimously resolved that the most appropriate memorial that could be raised to Mr. Hancock, would be a Professorship of Natural History in the Newcastle College of Physical Science, to be called, after him and his friend and conjoint worker, the late Mr. Alder, the "Hancock and Alder Professorship." Over 1,000*l.* were subscribed at the meeting, and we have reason to hope, from the general esteem in which the two men were held, the high value of their labours, and the great wealth of Newcastle and the surrounding district, that the remaining 4,000*l.* or 5,000*l.* necessary to endow a Natural History chair, will be raised without difficulty. Very few, even of scientific men, seem to be aware of the great amount and value of the work done by Mr. Hancock. The Rev. A. M. Norman, in speaking at the meeting, said that the nature and extent of the work done by Mr. Hancock, would only be realised by degrees. "His work was abstruse science; work which was labour, day by day, under the microscope; work which was carried on from week to week and from year to year, and which was published in the journals of the scientific associations; work which was at present not thoroughly understood even by scientific men, and which could only be fully appreciated and utilised years afterwards, when others should arise who devoted themselves to the same branches of science as Mr. Hancock had done."

THE Professorship of Zoology in the Royal College of Science, Dublin, has become vacant through the appointment of Prof. Traquair to the Keepership of the Natural History collections in the Museum of Science and Art, Edinburgh. Candidates for the appointment should apply, forwarding testimonials, to the secretary, Science and Art Department, South Kensington, S.W.

ON April 14 and following days, an Exhibition in Natural Science will be offered for competition, in connection with King's College, Cambridge. Candidates must be British subjects under twenty years of age, unless already undergraduates of the College, who are also eligible, if in their first or second year. The Exhibition is worth at least 80*l*. a year, and is tenable for three years, but not with any other Exhibition, Scholarship, or Fellowship. There will be three papers in Natural Science (including Chemistry, Physics, and Physiology), and papers in Elementary Classics and Mathematics.

NINETY-FOUR essays have been sent in in competition for the 100*l*. prize offered by Lord Cathcart, the president of the Royal Agricultural Society, for the best essay on the potato disease and its prevention; but the committee appointed by the council of the society to adjudicate the prize do not advise its being awarded to any of the competitors. They recommended, however, that a sum of money be granted for the purpose of inducing a competent mycologist to undertake the investigation of the life-history of the potato-fungus, *Peronospora infestans*, in the interval between the injury to the potato plant and the re-appearance of the fungus in the following year; and that the society should offer prizes for kinds of potatoes that would resist disease during a series of experiments to be continued for three successive years.

A CORRESPONDENT sends us a letter from Dr. A. B. Meyer in which the latter asserts that D'Albertis did not cross New Guinea at all, and that he himself is the only explorer who has done so. With regard to his statement that the fauna of New Guinea is not rich, he says he refers to the higher vertebrates; he intends to publish shortly a "Prodromus Faunæ Novæ Guinensis." The latitude of the point on MacCluer Gulf, at which he arrived in crossing, was 2° 38′, and not 20° 38′, as by an obvious misprint was stated in his article in vol. ix. p. 79 of NATURE.

A PECULIAR result has been arrived at by Professor Fick, of Würtzburg, in his experiments on the blood-pressure in the heart and aorta of the dog (Verhandl. d. physik. med., vol. iv. p. 223). He finds that if a straight tube is the manometer employed, the column of fluid rises higher when the lower end is in the aorta, than when in the left ventricle itself. There are several objections to the method adopted which might tend to the production of this extraordinary result, so contrary to all preconceivd notions and to the experience of M. Marey, who, when discussing the subject (Circ. du Sang., p. 192) remarks, "Frequently verified measurements, made by the employment of ampoules on the horse, show that the maximum pressure in the aorta is slightly more feeble than in the ventricle, though, in some cases, it is nearly the same." May it not be that the presence of the tube in the ventricle, and the associated imperfect closure of the semilunar valves, reduces the pressure in the one case, and that on its withdrawal into the aorta the heart again resumes its more vigorous action. It seems physically impossible that the aortic pressure should be greater than the ventricular during any portion of the systolic period in which the semilunar valves are open.

A VALUABLE contribution to anatomical science, by Prof. Turner, has appeared in the current number of the *Journal of Anatomy and Physiology*, in which the relations of the different cerebral convolutions to the parts of the brain-case with which they are in contact are discussed. Each lateral half of the scalp is divided with the aid of the best marked prominences and sutures as landmarks, into ten regions, which are again capable of further subdivision, and the convolutions found in each are stated. It is shown that the lobes of the brain by no means correspond exactly with the bones from which they have been named, but frequently extend under the cover of others, or only partially occupy the surfaces of their own. These observations are particularly valuable now that the subject of the localisation of the cerebral functions has attained such prominent importance.

CAPTAIN POTTER of the U.S. whaler *Glacier*, we learn from *La Nature*, says that he has discovered some relics of the Franklin Expedition in the Polar regions. Captain Potter left New Bedford, Mass., on July 19, 1871, and remained absent twenty-six months, most of which time he spent in the neighbourhood of the place where Franklin and his companions abandoned their vessels. At Repulse Bay a party of Esquimaux came to trade with Captain Potter. He was considerably surprised to see them offering in exchange for culinary utensils, part of a table-service of silver, which they declared belonged to the appointments of Franklin. There are two large tablespoons, two large four-pronged forks, an ordinary tea-spoon, and sugar-spoon. All these articles are of old-fashioned make. The natives assert that after having quitted their ships, Sir John and his companions separated into two bands, one of which took the direction of the Red River, and the other made for the territory of the Hudson's Bay Company. They say also that Sir John and his companions died solely from natural causes, and Captain Potter believes they speak the truth.

THE adult female Indian Rhinoceros, which has been in the Zoological Society's Gardens since July 1850, then not larger than a full-sized dog, died on Sunday last, having been ill for some time previously. The coldness of the weather and the fog were probably the exciting causes of its death, though no definite pathological changes have been found on *post-mortem* examination. There were no symptoms of senile decay. An interesting point may be mentioned, which is, that one of the wisdom teeth from the lower jaw was found in the cæcum, with the fangs and dentine entirely absorbed. This tooth must have been in this peculiar situation for some time, probably years, as it is almost unworn, whilst the corresponding molar on the opposite side is still in place, much worn, as is the same one in the maxilla of the same side; that opposite to the proper situation of the missing tooth being almost as complete as when it was cut. The large accumulation of hay in the cæcum, in which the tooth was embedded, appeared fresh and but little modified by the digestive process, so that it must have been there but a short time. In a Sumatran Rhinoceros, also, which died some time ago, two large beans were found in the cæcum, which could not have been introduced in the food for at least four or five months before the individual's decease.

WE have received a Catalogue of Apparatus suitable for Lectures and Class Instruction in, Subject VIII. Acoustics, Light, Heat, and IX. Magnetism and Electricity, in connection with the Science and Art Department. The object of the Catalogue, which contains the names of 141 different pieces of apparatus, is to show those articles on which the Department allows a discount of 50 per cent. It is of great importance that this Catalogue should become widely known, and we hope the facilities here offered for the acquisition of serviceable apparatu will be extensively taken advantage of.

THE fourth number of the circulars of the U.S. Bureau of Education for 1873 contains a list of publications by the members of certain college faculties and institutions of learning in the United States from 1867 to 1873, and constitutes quite a valuable record of scientific activity during that time. We hope the Bureau will continue such a publication yearly, and we only wish there was any prospect of a similar undertaking in our own country.

WE would draw attention to the efforts being made by the Directors of the London Polytechnic Institntion to give a scientific character to part of the entertainment which they provide for the public. Mr. E. V. Gardner is at present delivering the seventh and eighth of a series of lectures descriptive of "Inventions and Appliances Useful or Necessary to Everyday Life," the subjects being "Sugar: from the Cane to the Teacup," and "The Silber Light and Lightning." We wish the Directors of the Polytechnic success in this attempt to make their institution administer to instruction as well as amusement.

MR. J. D. PAINTER of Macclesfield sends us some very interesting ornithological notes relative to East Cheshire. A short time ago, a bird which had been hovering round the Grammar School for six weeks, was brought him; it had evidently been killed by a violent blow with either a stick or a stone. Upon examination it proved to be the Crested Lark (*Alauda cristata*), which is a common bird throughout the Continent of Europe, but not a native of Britain. Indeed, it is a very rare visitor, since only two or three instances are on record of its having been met with in this country. Occasionally, the neighbourhood of Macclesfield is resorted to by other strangers of the feathered tribe. Some few weeks since the Black-headed Gull (*Larus ridibundus*) was shot in Swithamley Park, and previous to that, on the same estate, the Common Buzzard (*Buteo vulgaris*) had been shot upon the Roaches. A few years further back the Roller (*Coracius garrula*), and a Hobby were killed two or three miles south of the town. In tempestuous weather the Stormy Petrel or Mother Carey's Chicken has been frequently picked up either dead or in an exhausted condition near Macclesfield: and Terns are occasionally shot. The Siskin is a winter visitor, some become victims to the bird-catchers, and the Brambling, also a winter visitor, is now and then shot or snared. Twenty-five years ago, that delightful songster the Woodlark bred about Gawsworth, but in like manner it became completely extinguished. The Grey or Wild Goose (*Anser ferus*) and the Curlew (*Numenius arquata*) came almost every year to breed on Danes Moss, but when the North Staffordshire Railway was carried across it these birds deserted it. Last year, however, the Curlew returned and nested, but some boys took the eggs when just upon the point of being hatched; and this year the birds have not been seen in the neighbourhood. A few Woodlarks have likewise returned lately, and they will most probably share the same fate as their predecessors, unless the forthcoming amended Birds' Act be extended to them and also to the Skylark, which have been most unaccountably omitted in the Act now in force. A few years ago Mr. Painter gave a lecture at the Town Hall upon the Geology, Archæology, Botany, Ornithology, and Zoology of Danes Moss and its borders, when he mentioned some rare and beautiful bog plants, &c. that grew upon it. In the course of a year or two nearly the whole of them were rooted up and carried away, chiefly by strangers.

THE additions to the Zoological Society's Gardens during the last week include a Zebu (*Bos indicus*) born in the Menagerie; a Greater White crested Cockatoo (*Cacatua cristata*) from Moluccas, presented by Mr. T. Towndrow; a Squirrel Monkey (*Saimaris sciurea*) from Guiana, presented by Mrs. Paget; a Parrot Crossbill (*Loxia pityopsittacus*) and two common Crossbills (*L. curvirostra*), European, purchased.

EFFECTS OF ALCOHOL ON WARM-BLOODED ANIMALS *

AFTER referring to what had already been done in reference to this subject, Prof. Binz gave an account of his and his pupils' researches during the last years. They concerned especially two points (1) the influence of alcohol on the temperature of the blood, and (2) the causes of this influence.

As in every powerful attack on our organism, so also in the case of alcohol, the questions arise—In what quantities it worked? and whether the organism to be experimented on was previously accustomed to its influence or not? Taking into exact consideration these two points, so often disregarded, the answer is as follows:—The pretended heat of the organism does not exist. The subjective impression is, at least partially, the consequence of an irritation of the nerves of the stomach and of the enlargement of the vessels arising in the skin. When given in small doses the thermometer shows no extraordinary increase or decrease of the temperature of the blood. Moderate doses, which lead by no means to drunkenness, show a distinct decrease of about half-an-hour duration or more; and inebriating quantities evince a still more decided lowering of 3 to 5 F., which lasts several hours. The decrease in the temperature after moderate doses takes place most successfully in warm-blooded animals, which have had for some time previously no alcohol administered. When inured to it, the organism does not answer on such doses by any measurable cooling or by the reverse.

Good results are yielded more easily by a feverish than by a healthy animal. For these experiments strong guinea-pigs, rabbits, or dogs of the same origin and of the same quality have been used. Under their skin some cubic-centimeter of ichor or putrifying blood was injected. After thus proceeding, the temperature of the animal rises several degrees, and all the symptoms appear which are to be observed in human beings suffering from putrid fever. If the quality of the poisonous substance be right, the animal expires in a few days. Not so, however, if, simultaneously with the ichor, alcohol diluted with water is administered. The temperature then remains lower from the beginning, and the one animal may be seen to die, whilst the other runs about. The analysis of these experiments shows a threefold action of alcohol in putrid fever—(1) the diminution of the heat; (2) reduction of the putrid processes; and (3) rising of the action of the nerves and of the heart.

Prof. Binz then remarked on the causes of such antipyretic action of alcohol. He pointed out several possibilities which here may concur, and has proved by a series of experiments that two of them really take place. It is the action of the heart, together with the enlargement of the vessels of the skin, which allow a stronger evolving of the blood at the surface of the body, and then the moderating influence of alcohol on the chemical metamorphosis of tissues. All these results seem to be suggestive for the use and abuse of alcohol in social life as well as in illnesses, and they explain a great many empiric observations in both departments. The paper of Prof. Binz will be published at length in one of the next numbers of *Humphrey's Journal of Anatomy and Physiology*.

Dr. Brunton remarked that the performance of the vital functions depended on oxidation of the tissues, and Professor Binz's observation that this was lessened by alcohol was the key to an explanation of its physiological effects. These may be nearly all explained on the supposition that the power of the nervous system is diminished, different parts of it becoming successively paralysed. First, the vasomotor nerves become affected and the blood-nerves consequently dilated. After a glass or two of wine, the hands may be noticed to be of a very red colour and plump, showing that arterial blood is flowing freely through the capillaries, and at the same time the veins are dilated and full. All the vessels of the body, however, are not dilated at the same time. In some persons those of the stomach or intestines become dilated, and the blood being thus abstracted from the head the brain becomes anæmic, and the individual dull and sleepy. In others the arteries of the head become dilated first, and in consequence the brain receives a full supply of blood, and the intellect becomes more vigorous. If this stage is not passed the functions return to their normal condition, and no harm ensues, but if more alcohol is taken the paralyis extends to other parts of the nervous system. Sometimes the cerebral lobes, which are the organs of the mental faculties, are first affected, and some-

* Abstract of paper read at the British Association, Bradford, by Prof. Binz, of Bonn, with Dr. Brunton's remarks.

times the centre, for co-ordinated movements usually supposed to be the cerebellum, or, as it is often expressed, "one man gets drunk in his head, another in his legs." When the head is affected judgment becomes impaired, though memory and imagination may still be more active than usual. These faculties next fail, and the emotions become hilarious, pugnacious, or lachrymose. The spinal cord is generally unaffected even when the cerebellum is paralysed, and a man who is utterly unable to walk can still ride, the mere pressure of the saddle upon his thighs being sufficient to cause reflex contraction of his adductor muscles and fix him firmly on his seat, although the upper part of his body may be swaying about like a sack of wheat. The cord itself next becomes paralysed, and lastly the medulla oblongata, which regulates the respiratory movements.

After relating an anecdote illustrative of the effects of alcohol in hastening death during exposure to cold, Dr. Brunton remarked that, notwithstanding all these apparently injurious actions, alcohol was of great service when properly used. Many men came home from their offices completely exhausted, and the stomach, sharing the general exhaustion, is unable to digest the food which lies heavily in it, and incommoding instead of strengthening the individual.

A glass of sherry taken with the food will stimulate the stomach to increased action, and by the time the effect of the stimulus has passed away the food has digested and absorbed, and sustains the effect which the alcohol temporarily produced. When taken in considerable quantities for a long time, alcohol is apt to produce deposit of fat and fatty degeneration of organs, rendering a person not only less capable of work, but liable to uccumb to disease.

SOCIETIES AND ACADEMIES

London

Royal Society, Dec. 11.—"Researches in Spectrum-Analysis in connection with the Spectrum of the Sun."—Part III., by J. Norman Lockyer, F.R.S.

The paper commences with an introduction, in which the general line of work since the last paper is indicated. Roughly speaking, this has been to ascertain the capabilities of the new method in a quantitative direction. It is stated that while qualitative spectrum-analysis depends upon the *positions* of the lines, quantitative spectrum-analysis on the other hand depends not on position but on the *length*, *brightness* and *thickness* of the lines.

The necessity of maps carefully executed and showing the individuality of each line is shown; and it is stated that the execution of these maps required the use of the electric arc to render the vapours of the metals incandescent. A battery of 30 Grove's cells of one pint capacity was accordingly employed in the researches about to be described.

The difficulties of eye-observations of the characters of the lines compelled the application of photography, another reason for the use of which existed in the facility it afforded for confronting spectra with each other, and so eliminating coincident lines, since the lines, if due to impurities, would be longest and thickest in the spectrum to which they really belonged.

The portion of the spectrum at present worked upon is that from H to F.

Another branch of the research has been the construction of a Table of all the named Fraunhofer lines, showing the lengths and thicknesses of the metallic lines to the absorption of which they were due; this Table enabled the author to allocate upwards of 50 lines in the solar spectrum, presumably overlooked by Angström and Thalén. The table was intended as a preliminary to a new photographic map of the spectrum from H to F, on a larger scale than Angström's, which was intended to clear away all the difficulties touching coincidences, and to have below it complete maps of all the solar elements with their long and short lines. This map is incomplete at present, but is making rapid progress

A preliminary search for elements supposed not to be in the sun has also been commenced.

Of the above-named researches the subsequent parts of the paper refer to :—

I. The experiments made on a possible quantitative spectrum-analysis.

II. The method of photographing spectra adopted.

III. The coincidences of spectrum lines.

IV. The preliminary inquiry into the existence in the sun of elements not previously traced.

I. *The Experiments made on a possible quantitative Spectrum-Analysis*

After the two former papers were sent in to the Royal Society, an investigation of the general changes undergone by spectra given by alloys was commenced.

A micrometer eye-piece was mounted on the observing-telescope of the spectroscope. With this the following phemonena were observed :—

I. The lines which remained varied their length as the percentage of the elements to which they were due varied.

II. Some of the lines appreciably varied their thickness or brightness, or both in the same way.

III. In cases where the brightness of a line was estimated through a considerable range of percentage composition by comparison with an air-line, the air-line was observed to grow faint and then disappear as the lightness of the metallic lines increased.

IV. In cases where the brightness or thickness of the line of one element was estimated by comparison with the line adjacent of the other constituent of the alloy, the point of equal brightness was observed to ascend or descend; this method was used to avoid the uncertainty of micrometric measurements of the tips of the lines in consequence of their variation in length due to the unequal action of the spark.

V. In some cases where the percentage of a constituent was so small that none of its lines were visible, there yet seemed to be an effect produced on the vapour of the opposite pole.

As these conclusions were derived from coarse alloys, and it was desirable to observe the effect of very fine gradation, Mr. C. Freemantle, the Deputy Master of the Mint, was begged to allow observations to be made on the gold-copper and silver-copper coinage alloys, and he immediately responded most cordially to the request.

Examples of the behaviour of some coarse alloys of silver and lead are given; they were irregular in their action, but it was observed that silver lines remained in the alloy as long as from ·05 to ·02 per cent. of silver was present. The alloys, however, were very unequal. Experiments on cadmium and tin alloys are described, the cadmium forming 10, 5, 1·0, 0·15 per cent. In the last but one cadmium line was permanent; in the first at least five were seen. In an alloy of 0·099 per cent. of cadmium with a mixture of lead, tin, and zinc constituting the rest of the alloy, the behaviour of the cadmium lines was sensibly the same as in a mixture of 0·1 per cent. of cadmium and 99·9 of tin.

In the Mint-specimens the same phenomena were observed *en petit*, as the coarser alloys showed *en grand*. In a gold-copper alloy $\frac{1}{1000}$ increase in the gold made the lines shorter, and a similar increase in the copper made them longer.

In the silver-copper alloy an increase of $\frac{1}{1000}$ in the silver lengthened the lines, a similar increase in the copper shortened them.

These phenomena can be explained by assuming such alloys to be different physical things, and that the spark acts upon the alloy as a whole as well as upon each vapour separately.

Thus in these Mint alloys, copper is common to both, and their melting-points are :—

Gold	1200° (Pouillet).
Copper	1200° to 1000°, the precise point not determined.
Silver .	1000° (Pouillet).

The intermediate position of copper explains the different action on its lines of gold and silver.

II. *The Method of photographing Spectra adopted*

A camera carrying a 5 × 5-inch plate and a 3-inch lens of 23 in. focus, replaced the observing-telescope of the spectroscope. The lens focused from 3900 to 4500 very fairly upon the plate. The beam passing through collimator and prisms was, as in Mr. Rutherford's researches, very small. As the electric arc in its usual vertical position gave all the lines from pole to pole, the lamp was placed on its side, and the arc used in a horizontal position, the slit being vertical. The dense core of the arc then gave all the short lines in the centre of the field, the longer ones extending beyond them on either side. In order to obtain a scale, it was resolved to photograph the solar spectrum immediately adjacent to the metallic spectrum under examination.

To effect this a portion of the slit was covered up while the solar spectrum passed through the free part, and then the part used for the solar spectrum was covered, while the formerly covered part was opened for the metallic spectrum. This was effected by a shutter, with an opening sliding in front of the slit; a diagram of its action and form is given.

The arrangement of the spectroscope, heliostat, &c., for obtaining the sun's light is described. The image of the sun was brought to a focus between the poles of the lamp by an extra lens interposed between the lamp and the heliostat.

The use of the shutter enables us to compare either two or more spectra upon a single plate, or the solar spectrum may be compared with two metallic spectra, being made to occupy the position between the two.

III. *On the Lines coincident in different Spectra*

The bearing of the former papers on the lengths of the lines of the elements is briefly recapitulated.

The examination of the various spectra of metals and alloys indicated the great impurity of most of the metals used, and suggested the possibility of the coincidences observed by Thalén and others being explained in the light of former work.

It is observed that coincidences are particularly numerous in the spectra of iron titanium, and calcium, and that nearly every other solar metallic spectrum has one or more lines coincident with lines of the last element. These coincident lines are, as a rule, very variable in length and intensity in various specimens of the metals in which they occur, and are sometimes altogether absent.

One of the longest calcium lines, that at wave-length 4226·3, is also seen in the strontium spectrum as a line of medium length, and 4607·5, a very long line in strontium, appears in calcium as a short line. Another very long strontium line, 4215·3, is asserted by Thalén to be seen in calcium; but the author has never seen it till lately, and *then only in a specimen of calcium known to contain strontium.*

We have here, then, a case of coincident lines, in which the one that is long and bright in one spectrum is short and faint in the other, and a case of a line said to be coincident in two spectra being, though always visible in one, sometimes absent in the other of them, and only appearing in it when the two substances were mixed. The hypothesis of impurity at once explains the whole case, even without the third line, which renders the fact of mixture certain.

The longest lines of calcium occur in iron, cobalt, nickel, barium, strontium, &c., and the longest lines of iron occur in calcium, strontium, barium, and other metals.

Other cases are adduced, and the following general statements are hazarded, with a premise that further inquiry may modify them.

1. If the coincident lines of the metals be considered, those cases are rare in which the lines are of the first order of length in all the spectra to which they are common: those cases are much more frequent in which they are long in one spectrum and shorter in the others.

2. As a rule, in the instances of those lines of iron, cobalt, nickel, chromium, and manganese which are coincident with lines of calcium, the calcium lines are long, while the lines as they appear in the spectra of the other metals are shorter than the longest lines of those metals. Hence we are justified in assuming that short lines of iron, cobalt, nickel, chromium, and manganese, coincident with long and strong lines of calcium, are really due to traces of the latter metal occurring in the former as an impurity.

3. In cases of coincidences of lines found between various spectra the line may be fairly assumed to belong to that one in which it is longest and brightest.

A description of some photographs of spectra is then given, a photograph of the coincident lines of calcium and strontium being amongst them, and proving that strontium occurs in the sun; and the section concludes with a brief description of the method employed in making the new map, showing lengths and thicknesses, and enumerating coincident lines. This is done thus: papers are pasted on to photographs of the solar spectrum on glass; the lengths of the lines of the metallic spectrum under examination (*e.g.* that of iron) are marked on this paper in prolongation of the solar lines to which they correspond. They are then copied upon a map, and another piece of paper being fixed down, another spectrum is proceeded with in the same way.

IV *The Preliminary Inquiry into the Existence of Elements in the Sun not previously traced*

The previous researches having shown that the former test for the presence or absence of a metal in the sun, namely, the presence or absence of its brightest or strongest lines in the average solar spectrum, was not conclusive, a preliminary search for other metals was determined on; and as a guide, Mr. R. J. Friswell was requested to prepare two lists, showing broadly the chief chemical characteristics of the elements traced and not traced in the sun.

The tables showed that in the main those metals which had been traced formed stable compounds with oxygen.

The author therefore determined to search for the metals which formed strong oxides, but which had not yet been traced.

The result up to the present time has been that *strontium, cadmium, lead, cerium,* and *uranium* would seem with considerable probability to exist in the solar reversing layer. Should the presence of *cerium* and *uranium* be subsequently confirmed, the whole of the iron group of metals will thus have been found in the sun.

Certain metals forming unstable oxides, such as gold, silver, mercury, &c., were sought for and not found. The same was the case when chlorine, bromine, iodine, &c., were sought by means of their lines produced in tubes by the jar-spark. These elements are distinguishable as a group by forming compounds with hydrogen.

It is observed that certain elementary and compound gases effect their principal absorption in the most refrangible part of the spectrum when they are rare, and that as they become dense the absorption approaches the less refrangible end; that the spectra of compounds are banded or columnar, the bands or columns lying at the red end of the spectrum; that the absorption spectra of chlorine, iodine, bromine, &c., are columnar, and that these are broken up by the spark just as the band spectra of compounds are broken up: and that it is probable that no compounds exist in the sun. The following facts, gathered from the work already accomplished by Rutherford and Secchi are stated:—

There are three classes of stars:—

1. Those like Sirius, the brightest (and therefore hottest?) star in the northern sky, their spectra showing only hydrogen lines very thick, and metallic lines exceedingly thin.

2. A class of stars with a spectrum differing only in degree from those of the class of Sirius, and to this our sun belongs.

3. A class of stars with columnar or banded spectra indicating the formation of compounds.

The question is asked whether all the above facts cannot be grouped together in a working hypothesis, which assumes that in the reversing layers of the sun and stars various degrees of "celestial dissociation" are at work which prevents the coming together of the atoms which, at the temperature of the earth, and at all artificial temperatures yet attained here, form the metals, the metalloids, and compounds.

In other words, the metalloids are regarded as *quasi* compound bodies when in the state in which we know them; and it is supposed that in the sun the temperature is too great to permit them to exist in that state in the reversing layer, though they may be found at the outer portions of the chromosphere or in the corona.

It is suggested that if this hypothesis should gain strength from subsequent work, stony meteorites will represent the third class of metalloidal or compound stars, and iron meteorites the other, or metallic stars.

The paper concludes as follows:—

"An interesting physical speculation connected with this working hypothesis is the effect on the period of duration of a star's heat which would be brought about by assuming that the original atoms of which a star is composed are possessed of the increased potential energy of combination which this hypothesis endows them with. From the earliest phase of a star's life the dissipation of energy would, as it were, bring into play a new supply of heat, and so prolong the star's life.

"May it not also be, if chemists take up this question, which has arisen from the spectroscopic evidence of what I have before termed the plasticity of the molecules of the metalloids taken as a whole, that much of the power of variation which is at present accorded to metals may be traced home to the metalloids? I need only refer to the fact that, so far as I can learn, all so-called changes of atomicity take place when metalloids are involved, and not when the metals alone are in question.

"As instances of these, I may refer to the triatomic combinations formed with chlorine, oxygen, sulphur, &c. in the case of tetrad or hexad metals. May not this be explained by the plasticity of the metalloids in question?

"May we not from these ideas be justified in defining a metal, provisionally, as a substance the absorption spectrum of which is generally the same as the radiation spectrum, while the metalloids are substances the absorption spectrum of which, generally, is not the same?

"In other words, in passing from a hot to a comparatively cold state, the plasticity of these latter comes into play, and we get a new molecular arrangement. Hence are we not justified in asking whether the change from oxygen to ozone is but a type of what takes place in all metalloids?"

Abstract of paper "On the Quantitative Analysis of certain Alloys by means of the Spectroscope," by J. Norman Lockyer, F.R.S., and William Chandler Roberts, Chemist of the Mint.

The authors, after referring to experiments which showed clearly that the spectroscope might be employed to detect minute differences in the composition of certain alloys, proceed to give an account of the researches which they had instituted with a view to ascertain the degree of accuracy of which the method is capable.

The image of an electric-spark passing between the unknown alloy and a fixed electrode being thrown by means of a lens on the slit of the spectroscope, the phenomena observed were found to vary with the composition of the alloys; and further, by arranging them together with known check-pieces on a suitable stand, and bringing them in turn under the fixed electrode, the composition of the unknown alloys was determined by comparison with the known check-pieces.

The shape of the electrode ultimately adopted was stated; the pieces were held in their places by suitable metallic clips. Special attention was then directed to the adjustment of the length of the spark, which was found to materially influence the phenomena. The method adopted consisted in placing the variable electrode in the field of a fixed microscope having a 3- or 4-inch objective, and adjusting the summit of this electrode to coincide with the spider lines of the eye-piece.

After a series of experiments on alloys of zinc and cadmium of various compositions, the results of which were shown on a curve, more extended trials were made with the gold-copper alloy employed in coinage, which was peculiarly suited to these researches in consequence of the known method of assay having been brought to so high a state of perfection (the composition being determined with accuracy to the $\frac{1}{10000}$ part of the original assay-piece of about 7 grains), and from the fact that reliance can be placed on its homogeneity. The paper is accompanied by a series of four curves, which show the results of experiments, and in which the coördinates are given by the ordinary method of assay, and by the spectroscopic readings.

The chief practical advantage which appeared to flow from this inquiry was that, if it were possible to replace the parting assay by the spectroscopical method, a great saving of time in ascertaining the value of gold bullion would be effected.

Institution of Civil Engineers, Dec. 9.—T. Hawksley, president, in the chair.—"On the Geological Conditions affecting the Constructing of a Tunnel between England and France," by Mr. Joseph Prestwich, F.R.S. The author reviewed the geological conditions of all the strata between Harwich and Hastings on one side of the Channel, and between Ostend and St. Valery on the other side, with a view to serve as data for any future projects of tunnelling, and to show in what directions inquiries should be made. The points considered were the lithological characters, dimensions, range and probable depth of the several formations. The London clay, at the mouth of the Thames, was from 200 feet to 400 feet thick, while under Calais it was only 10 feet, at Dunkirk it exceeded 264 feet, and at Ostend it was 448 feet thick. He considered that a trough of London clay from 300 feet to 400 feet, or more, in thickness extended from the coast of Essex to the coast of France, and, judging from the experience gained in the Tower Subway, and the known impermeability and homogeneity of this formation, he saw no difficulty, from a merely geological point of view, in the construction of a tunnel, but for the extreme distance —the nearest suitable points being 80 miles apart. The lower Tertiary strata were too unimportant and too permeable for tunnel work. The chalk in this area was from 400 feet to 1,000 feet thick; the upper beds were soft and permeable, but the lower beds were so argillaceous and compact as to be comparatively impermeable. In fact, in the Hainaut coal fields they effectually shut out the water of the water-bearing tertiary strata from the underlying coal measures. Still, the author did not consider even the lower chalk suited for tunnel work, owing to its liabilty to fissures, imperfect impermeability, and exposure in the Channel. The gault was homogeneous and impermeable, but near Folkstone it was only 130 ft. thick reduced to 40 ft. at Wissant, so that a tunnel would hardly be feasible. The Lower Greensands, 260 ft thick at Sandgate, thinned off to 50 ft. or 60 ft. at Wissant, and were all far too permeable for any tunnel work. Again, the Wealden strata, 1,200 ft. thick in Kent, were reduced to a few unimportant rubbly beds in the Boulonnais. To the Portland beds the same objections existed as to the Lower Greensands, both were water-bearing strata. The Kimmeridge clay was 360 ft. thick near Boulogne, and no doubt passed under the Channel, but in Kent it was covered by so great a thickness of Wealden strata as to be almost inaccessible; at the same time it contained subordinate water-bearing beds. Still, the author was of opinion that, in case of the not improbable denudation of the Portland beds, it might be questionable to carry a tunnel in by the Kimmeridge clay on the French coast, and out by the Wealden beds on the English coast. The oolitic series presented conditions still less favourable, and the lower beds had been found to be water-bearing in a deep artesian well recently sunk near Boulogne. The experimental deep-boring now in progress near Battle would throw much light on this part of the question. The author then passed on to the consideration of the Palæozoic series, to which his attention was more particularly directed while making investigations, as a member of the Royal Coal Commission, on the probable range of the coal measures under the south-east of England. He showed that these rocks, which consisted of hard Silurian slates, Devonian and carboniferous limestone and coal measures, together 12,000 ft. to 15,000 ft. thick, passed under the chalk in the North of France, outcropped in the Boulonnais, were again lost under newer formations near to the coast, and did not reappear until the neighbourhood of Frome and Wells was reached. But, although not exposed on the surface, they had been encountered at a depth of 1,032 ft. at Calais, 985 ft. at Ostend, 1,026 ft. at Harwich, and 1,114 ft. in London. They thus seemed to form a subterranean table land of old rocks, covered immediately by the chalk and Tertiary strata. It was only as the southern flank of this old ridge that the Jurassic and Wealden series set in, and beneath these the Palæozoic rocks rapidly descended to great depths. Near Boulogne these strata were already 1,000 ft. thick; and at Hythe the author estimated their thickness might be that or more. Supposing the strike of the coal measures and the other Palæozoic rocks to be prolonged from their exposed area in the Boulonnais across the Channel, they would pass under the Cretaceous strata somewhere in the neighbourhood of Folkestone, at a depth estimated by the author at about 300 ft., and near Dover at about 600 ft., or nearly at the depth at which they had been found under the chalk at Guines, near Calais, where they were 665 ft. deep. These Palæozoic strata were tilted at high angles, and on the original elevated area they were covered by horizontal Cretaceous strata, the basement beds of which had filled up the interstices of the older rocks as though with a liquid grouting. The overlying mass of gault and lower chalk also formed a barrier to the passage of water so effectual, that the coal measures were worked without difficulty under the very permeable Tertiary and upper chalk of the North of France; and in the neighbourhood of Mons, notwithstanding a thickness of from 500 ft. to 900 ft. of strata charged with water, the lower chalk shut the water out so effectually that the coal measures were worked in perfect safety, and were found to be perfectly dry under 1,200 ft. of these strata combined. No part of the Straits exceeded 186 ft. in depth. The author, therefore, considered that it would be perfectly practicable, so far as safety from the influx of the sea water was concerned, to drive a tunnel through the Palæozoic rocks under the Channel between Blanc Nez and Dover, and he stated that galleries had actually been carried in coal, under less favourable circumstances, for two miles under the sea near Whitehaven. But while in the case of the London clay the distance seemed almost an insurmountable bar, here again the depth offered a formidable difficulty. As a collateral object to be attained, the author pointed to the great problem of the range of the coal measures from the neighbourhood of Calais in the direction of East Kent, which a tunnel in the Palæozoic strata would help to solve. These were, according to the author, the main conditions which bore on the construction of a submarine tunnel between England and France. He was satisfied that on geological grounds alone, it was in one case perfectly practicable, and in one or two others it was possibly so; but there were other considerations besides those of a geological nature, and whether or not they admitted of so favourable a solution was questionable. In any case, the author would suggest that, the one favourable solution admitted, it might be desirable, in a question involving so many and such great interests, not to accept an adverse verdict without giving all those considerations the attention and deliberation which the importance of the subject deserved. Granting the possibility of the work in a geological point of view, there were great and formidable engineering difficulties; but the vast progress made in engineering science during the last half century, led the author to imagine that they would not prove insurmountable, if the necessity for such a work were to arise, and the cost were not a bar.

Royal Astronomical Society, Dec. 14.—Prof. Cayley, president, in the chair.—Prof. Pritchard gave a verbal account of the Physical Observatory about to be established at Oxford. He said that the University authorities had been induced to grant a site for a physical observatory in the noble park of sixty acres, which they had recently thrown open to the public. He had been anxious that such a site should not be disgraced by an unsightly building such as observatories usually were. He found himself fortunately situated in having amongst his old pupils Mr. Barry, the well-known architect, who had furnished them with a design which he showed to the meeting, and had devised, amongst other things, a dome with a fine broad shutter, which he trusted would be really ornamental as well as useful. There would be a central tower of three rooms, one above the other; the basement room would be used for storage; above would be the professor's room; and in the floor above that would be mounted the noble reflector which had been presented to the University by Dr. De La Rue. In a side wing there would be a transit instrument to be used for educational purposes, and another telescope which he hoped would be well worked by members of the University. Mr. Barry informed the society that their new rooms at Burlington House would probably be ready by the middle of April.—Capt. Noble mentioned to the society that in the new volume of the *Nautical Almanac* for 1877 tables of Uranus were given, but it was no credit to England that we should have been kept waiting for them until they were presented to us from across the Atlantic by the labour of Prof. Simon Newcomb.

Entomological Society, Dec. 1.—H. T. Stainton, F.L.S., vice-president, in the chair.—Mr. Bond exhibited a hybrid specimen between *Clostera curtula* and *C. reclusa* partaking of the characters of both parents.—Mr. Jenner Weir exhibited specimens of a minute Hymenopterous insect (a species of *Psen*), which he had observed in large numbers (probably 150) in June last on a pear leaf at Lewes. They had congregated together on the surface of the leaf like a swarm of bees, though it was not apparent what motive brought them together.—Mr. Dunning read extracts from a letter from New Zealand stating that the red clover had been introduced into that colony, but that they had no humble bees to fertilise the plant. Also that certain Lepidopterous insects had been accidentally imported into the islands, but that the corresponding Ichneumon flies were wanted to keep down their numbers. It was suggested that the nests of humble bees might be imported, when the bees were in a dormant condition, keeping them in that state (by means of ice) during the voyage.—Mr. Baly communicated a paper on the Phytophagous Coleoptera of Japan, being a continuation of a former paper on the same subject.—Mr. Bates communicated a supplementary paper on the Longicorn Beetles recently brought from Chontales, Nicaragua, by Mr. Thomas Belt.—Mr. W. H. Miskin, of Queensland, communicated criticisms on Mr. Masters' Catalogue of the described species of Diurnal Lepidoptera of Australia.—A fourth portion of the catalogue of British Insects, now being published by the society, was on the table. It contained the Hymenoptera (*Oxyura*), by Rev. T. A. Marshall, M.A.

PARIS

Academy of Sciences, Dec. 8.—M. de Quatrefages, president, in the chair.—The president announced the death of M. Cl. Gay, member of the Botanical Section; and the Perpetual Secretary also announced the death of the well-known mineralogist, C. F. Naumann, Corresponding Member of the Mineralogical Section.—The following papers were read:—An answer to M. Pasteur's paper on the origin of beer yeast, by M. A. Trécul. The author contradicted M. Pasteur's statement that the development of *Pencillium glaucum* from *putrid* yeast was an admitted fact. On the contrary, it had been observed to develop itself from perfectly healthy yeast.—On the vitreous substances found included in Santorin lava, by M. F. Fouqué.—On the determination of the ratio of two specific heats by the compression of a limited volume of gas, by M. E. H. Amgat.—On the distribution of the neolithic populations in the department of the Oise, by M. R. Guérin.—On the habits of the *Phylloxera* (continued), by M. Max. Cornu.—A further notice on the connection of storms and sunspots as observed at Paris and Fécamp was received from M. Poëy.—Preliminary note on the elements existing in the sun, by Mr. Norman Lockyer. M. Berthelot then criticised the paper. He held that the phenomena of specific heat, &c., indicated that the elements, so-called, were on a very different basis from the compounds, and that the phenomena they presented in this respect could not be explained if they were not regarded as actually simple bodies. M. Dumas thought that, as he had himself maintained before the Academy, elements ought only to be regarded as elements in relation to human experience and not as absolute elements, a fact which he considered Lavoisier to have established. He considered that modern experiments tended to confirm this opinion.—Note on the identity of Cauchy's formulæ for the determination of the conditions of convergence of Lagrange's series with those given by Lagrange himself, by M. L. F. Ménabréa.—On the November meteors, by M. Wolf.—Note on Faye's periodic comet and on the discovery and observations of twenty nebulæ made at the Marseilles observatory, by M. E. Stephan.—On the movement of an elastic wire one end of which has a vibratory motion, by M. E. Mercadier.—Observations on the action of certain poisons on sea fish, by MM. A. Rabuteau and F Papillon.—On the embryo cell of the egg of osseous fish, by M. Balbiani.—On the age of the dental follicle in the *mammifera*, by MM. E. Magitot and Ch. Legros.—On the use of electrical cauterisation in surgical operations, by MM. Ch. Legros and Onimus.—On the Ostrœacious marl of Fresnes-lès-Rungis (Seine), by M. Stan. Meunier.—Note on a meteor observed at Versailles on Dec. 3, by M. Martin de Brettes.—New analysis of the water of St. Thiébaut's fountain at Nancy, by M. P. Guyot.—Studies on certain combustibles from the basin of Donetz and Toula, Russia, by MM. Scheurer-Kestner and Meunier-Dollfus.

BOOKS RECEIVED

ENGLISH.—Guide to Latin Prose: R. M. Millington (Relfe).—Wild Animals: Wolf (Macmillan & Co.).—Problems of Life and Mind: George Henry Lewes (Trübner & Co.).—Theory of Attraction. 2 vols.: Todhunter (Macmillan & Co.).—The Borderland of Science: R. A. Proctor (Smith, Elder & Co.).—Memoir of Mary Somerville: Martha Somerville (John Murray).—Manual of Comparative Anatomy and Physiology: J. M. Bradley (Simpkin and Marshall).—The River Amazon: H. W. Bates (John Murray).—The Chase: Somerville (W. Tegg).—Virgil's Eclogues. Translated: Millington (Longmans).—Quantitative Chemical Analysis. 6th edition: Fresenius (Churchill).—Nautical Almanac, 1877 (John Murray).—The Simplicity of Life: Dr. Ralph Richardson (H. K. Lewis).—Introduction to Quaternions: Kelland and Tait (Macmillan)—Free-thinking and Plain Speaking: Leslie Stephens (Longmans).—United States Geological Survey. 6th Annual Report: F. W. Haydyn (Trübner & Co.)—Harvest of the Sea: Bertram (John Murray).—Mountain, Meadow, and Mere: G. C. Davies (H. S. King & Co.).—Legal Handbook for Architects: Jenkins and Raymond (H. S. King & Co.).—The Conservation of Energy: Balfour Stewart (H. S. King & Co.).—Telegraphic Journal, vol. i. (Gillman).—Primer of Geology: A. Geikie (Macmillan & Co.).—Darwinism and Design: G. St. Claire (Hodder & Stoughton).—From January to December (Longmans).—Pheasants for Coverts and Aviaries: W. B. Tegetmeier (Horace Cox).

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