THURSDAY, JANUARY 26, 1899.

THE PHYSIOLOGY OF MAN AT HIGH ALTITUDES.

Life of Man on the High Alps. By Angelo Mosso. Translated from the Second Edition of the Italian by E. Lough Kiesow. Pp. xv + 342. (London: T. Fisher Unwin, 1898.)

The Annals of Mont Blanc. By Charles Edward Mathews. Pp. xxiv + 368. (London: T. Fisher Unwin, 1898.)

THE modifications which are produced in the organism by residence at great heights differ in many respects from those witnessed in laboratory experiments where men or animals are subjected to diminished pressures in a pneumatic chamber. For this reason the observatories and huts on Mont Blanc and Monte Rosa have during the last few years afforded a shelter to several physiologists, and the results of a most extensive series of researches which were carried out in the Regina Margherita hut on Monte Rosa, at a height of 14,592 feet, are to be found in the "Fisiologia dell 'uomo sulle Alpi," by Prof. Angelo Mosso of Turin. This volume stands alone in scientific Alpine literature. It is the first attempt that has been made to present the various complex physiological phenomena which man exhibits at high altitudes, in such a form as to be easily understood by those who are not trained physiologists. Whether this attempt has been entirely successful is a matter of some doubt. It is a much better book than that of D. Jourdanet, on the "Influence de la pression de l'air sur la vie de l'homme," a huge volume of over 600 pages, which treats of the same subject.

The book is well translated, and it is seen that Prof. Mosso has carried out his researches with special physiological apparatus, some of which was designed for the particular study of man at high altitudes. The book contains some excellent tracings, which record the pulse and heart-movements. Records of the cerebral pulse taken with Marey's tambour, and of the blood-pressure in the limbs obtained with the plethysmograph are also given. Using Bianchi's phonendoscope, Prof. Mosso obtains some figures which are rather alarming to look at, showing that there is a normal physiological dilatation of the heart during a mountain ascent; after exercise the left side of the organ is enlarged, and in one figure the apex is displaced downwards, in the other the displacement is upwards. Many tracings were taken of the respiratory movements, and one of the most interesting is a record of the onset and culmination of a fainting fit. Phasic respiration or Cheyne-Stokes breathing is common at great heights, and especially well seen during sleep; complete cessation of movement for as long as twelve seconds separated the respiratory phases in the case of U. Mosso. The respiratory organs also tend to pause at the end of expiration. It is a well-recognised fact that the stature diminishes during the day, but a mountain ascent may produce such a flattening of the lumbar curve that a man may be an inch and a half shorter when he reaches the summit of Monte Rosa than he was in the plains.

Enough has been said to show that this book is of great interest, and since it is possible that the great authority of Prof. Mosso, who is well known in this country as a distinguished physiologist, may cause this volume to be regarded as the standard work on the physiology of man at great altitudes, it is necessary to point out some of the very unexpected facts which are stated, and remarkable theories which are advanced by Prof. Mosso, although the very discursive way in which the whole book is written makes this a matter of some difficulty. This volume is really neither a popular nor a scientific study of the phenomena of life at high levels. It is partly the one and partly the other. It is impossible from the information which is given to judge of the correctness of several of Prof. Mosso's views; and with a full knowledge of the exceedingly laborious work which was carried on for some weeks in the uncomfortable surroundings of an Alpine hut, it is a matter of regret to have to say that some of the results carry but little conviction to the mind of a physiologist, while those who are not in a position to weigh the evidence that is given, may make the mistake of imagining that many questions of great difficulty and complexity have been finally answered.

At an altitude of 14,800 feet, Prof. Mosso states that much more work can be accomplished than at the sea-level, and also that there is no increase in the frequency of respiratory movement; indeed, both the frequency and amplitude may be diminished, or with a frequency exactly like the normal the amplitude may be less. This phenomenon is certainly unexpected, and so is the remarkable statement that on the summit of Monte Rosa the rate of breathing was not always altered even by fatiguing muscular work. Mosso has shown that on the plains there is a *luxus-respiration*, the organism takes in a quantity of oxygen which is more than sufficient for its immediate needs; at a great height the breathing is not augmented, since though less oxygen is actually consumed it is enough, but not more than enough, for the needs of the organism. It has, however, been proved by actual experiments on mountains that when a height of only 8900 feet is reached, even at rest there is a slight increase in the gas exchanges and in the rate of breathing; while at 14,800 feet there is a great increase in both of these, indicating that whatever may be the cause there is a marked rise of metabolism at a diminished pressure of 425 mm. Prof. Mosso refers to these experiments, which were made by the brothers Loewy and Leo Zuntz, but they do not, of course, support his views on mountain-sickness. On p. 192 mention is made of the observations of Benedicenti on combustion in rarefied air. Prof. Mosso regards these "as intimately connected with the study of respiration in the Alps because, since the celebrated experiments of Lavoisier, it is a well-known fact that breathing in many respects resembles combustion." This analogy is entirely misleading, for the whole process of respiration, either internal or external, is exactly the reverse of combustion. The consumption of oxygen by an organism is wel known to be dependent not on the amount of this gas which is available, but on the necessities of the animal; variations between 12·5 and 60 per cent. of oxygen have scarcely any influence on the magnitude of the gas-exchanges in respiration.

Though most of the evidence in this book is not in favour of the idea that there is an anoxyhæmic condition of the blood at great altitudes, the new theories which are advanced can only be accepted when more experimental work has been accomplished. As to the changes in the blood on the Alps, on the question whether the undoubted increase in number of red corpuscles is real or apparent, Prof. Mosso is in accord with many physiologists in considering that the cause of the variations lies in the climatic conditions, in the more active influence of the sun's rays, in the greater dryness of the air, and in the altered mode of life. His own observations on this subject, which is one of the greatest interest, are open to the objection which may be taken to so many of the facts in this book, that the method of conducting the experiments is described, but the description is insufficient to enable a fair criticism to be made as to the value of the work. His contention that if Suter found an increase of 6·4 per cent. in the number of red corpuscles at a height of 1300 feet, the blood of those on Monte Rosa should show an increase of 64 per cent., which he regards as absurd, might possibly be found to be the case, since Viault's figures for a lower level showed an increase of 3,000,000 corpuscles per cubic millimetre of blood.

The cause of mountain-sickness is maintained by Prof. Mosso to be due to an actual diminution in the quantity of carbonic acid in the blood, the theory of *acapnia*, which assumes that this gas is the normal exciting agent for causing a discharge from the nerve-cells in the medulla oblongata. Mountain-sickness is in fact an asphyxia that is dependent not upon want of oxygen, but on a want of carbonic acid. He affirms that mountain-sickness is generally worse at night, and that this is due to a diminished production of carbonic acid when a man is at rest. The experience of many climbers is the contrary; mountain-sickness may occur quite suddenly during an ascent. There are members of the Alpine Club who have never reached the summit of Mont Blanc even after repeated attempts; a limit of 13,000 feet on this mountain cannot be passed without exceeding distress. The same individuals can, however, reach the summit of Monte Rosa. That there is really a deficiency of carbonic acid in the blood at great heights is most difficult of proof. Prof. Mosso refers to the analyses of the blood-gases made by Fraenkel and Geppert in 1883, and though these may show a slight decrease in the amounts of the carbonic acid, the differences are almost within the limits of experimental error. There is no fixed figure which decisively gives the actual amount of this gas in the blood. At the sea-level the amount of carbonic acid in arterial blood of the same species of animal may vary from 42·63 to 23·9 per cent. or from 53·4 to 23·3 per cent. If Prof. Mosso uses selected cases from Fraenkel and Geppert's tables in order to strengthen his position, it may be pointed out that their analyses show that with a rarefied atmosphere corresponding to 23,000 feet, the blood may actually contain more carbonic acid than at the sea-level. Even if it could be shown by data far more convincing than those given by Prof. Mosso, that there is an alteration in the output of carbonic acid at great heights, we should not be justified in regarding this as evidence of an alteration in the carbonic acid of the blood. To advance one hypothesis against another, it is conceivable that since an organism with excess of carbonic acid in the blood strives to eliminate this by increased frequency of breathing, an organism that possesses less of this valuable gas in its blood would tend to preserve a constant percentage in this liquid by exhaling, first of all, a less amount, and perhaps at last hardly any of the gas, in the same way as an animal is known to preserve the proteid constituents of its body at the expense of the fats and carbohydrates during starvation.

In the experiment on p. 298, where it is shown that the effects of diminished pressure may be counteracted by administration of air with 16·7 per cent. of carbonic acid, there would appear to be an error, for if the gas-mixture was made as is described, the original air of the laboratory must have contained 8 per cent. of carbonic acid. As to the action of this gas on the organism, according to Prof. Mosso's experiments, it essentially produces a slackening of the cardiac movements, which is seen not at the sea-level, but when the organism is subjected to the action of rarefied air. It may be admitted that there is a prompt reaction to a slight increase of carbonic acid in inspired air, and comparatively none to the same proportional diminution of oxygen, but since it is not possible to show that a slight excess or diminution of oxygen in inspired air is followed by any excess or diminution of this gas in the blood, it is probable that the effect of an increase of carbonic acid in inspired air acts in a reflex manner, and not by an action on some part of the central nervous system after it has been absorbed by the blood. That definite constriction of the bronchioles occurs as the result of a reflex action after the inhalation of small percentages of carbonic acid is a well-established fact, and there is every probability, or at any rate the possibility, which Prof. Mosso does not discuss, that an increased percentage of carbonic acid acts in a similar way. In the pneumatic chamber Prof. Mosso has succeeded in withstanding a rarefaction of the air when the barometer stood at 192 mm. This corresponds to an altitude of 37,862 feet. At the commencement of the experiment the pressure was 742 mm. After about an hour, when the pressure is 292 mm., oxygen is inhaled by allowing about 100 litres of the gas to enter the pneumatic chamber. The pulse rate has fallen below the normal, the heart beats 64 per minute, and the rate of respiratory rhythm is 19. Half an hour later, at a pressure of 192 mm, the pulse is 84 and respiration 18. The oxygen percentage by weight in the chamber at 292 mm. was 8·45 before oxygen was allowed to flow in, and 8·14 parts by weight when the pressure had fallen to 192 mm. The air of the chamber now contained 2·1 per cent. of carbonic acid, but contained only ·8 per cent. of this gas when the pressure was 292 mm. Prof. Mosso's interpretation of this interesting experiment is that he sustained a diminution of pressure from 292 to 192 mm., on account of the presence of this 2·1 per cent. of carbonic acid. Though he admits that oxygen has a distinctly beneficial action in reducing the frequency of the heart-beats, he considers that the increased percentage of carbonic acid in the inspired air prevented asphyxia, or using his own term *acapnia*, a condition which can be set aside by a high percentage of carbonic acid, since the barometric depression acts in a mechanical and physical manner by drawing this gas out of the blood. It may be pointed out that it is evident that Prof. Mosso's experiment might well bear another explanation, for it does not show more than that the respiration of an atmosphere containing 8·4 per cent of oxygen is sufficient for the needs of a man during a short period. Diminution of the carbonic acid of the blood, and a paralysis of the terminations of the vagi nerves will, according to Prof. Mosso, account for the headache, dizziness, vomiting, and other symptoms which are noticeable in mountain-sickness, whether this is met with in a slow or an acute form. Vomiting is undoubtedly a frequent symptom, but that this is caused by paralysis of the vagi nerves is not in complete accord with experimental evidence. The ease or difficulty with which this act is accomplished varies in different animals, and it is found that severing the vagi produces variable results; vomiting may occur, but often does not, and further vomiting is asserted not to occur at all after section of these nerves. Some physiologists, such as Bernstein, distinctly state that the vagus plays no essential part in the nervous mechanism which is concerned in vomiting. On p. 258 the distress of angina pectoris is regarded as resembling the distress of mountain-sickness. This appears to be hardly the case; certainly vomiting is not, as Prof. Mosso distinctly states it is, a characteristic symptom of angina pectoris.

No doubt Prof. Mosso may adduce some additional evidence in support of his views. Most physiologists attribute the excitation of nerve centres rather to the lack of oxygen than to the presence of carbonic acid. We must expect analyses of the blood gases to be given, which shall definitely show that a diminished barometric pressure is associated with a constant diminution of carbonic acid in the blood, and, further, it must be shown that an atmosphere with increased percentages of carbonic acid causes the blood to take up and retain this gas, before it can be admitted that Prof. Mosso's theory of *acapnia* has solved the problem of mountain-sickness.

In "The Annals of Mont Blanc," by C. E. Mathews, a volume which is beautifully printed, and contains excellent illustrations, an historical account of the ascents of this mountain is given. In this work an attempt is made to rehabilitate the reputation of Dr. Paccard, who made the first ascent with Balmat. The rival merits of these two pioneers is discussed, and the hope expressed that tardy justice may yet be made to Dr. Paccard. A very graphic and interesting account is given of the caravan of about forty people which started off in 1851 with Albert Smith, whose subsequent entertainment with Beverley's panorama at the Egyptian Hall may, in a sense, be considered to have introduced the beauties of the Chamonix valley to the attention of Englishmen. It is said that every one climbs Mont Blanc now; men have climbed it without guides; women have climbed it; blind men have reached the summit. With two observatories close to the summit, those of Vallot and Janssen, the mountain may almost be regarded as having become inhabited. The chapter on the geology of Mont Blanc is contributed by Prof. T. G. Bonney. The volume also contains a bibliography of Mont Blanc, and an appendix with good facsimiles of the "Glacieres in Savoy," published in 1744.

G. A. B.

GERMAN CHINA—TWO BOOKS ON SHANTUNG.

Schantung und seine Eingangspforte Kiautschou. Von Ferdinand Freiherr von Richthofen. Mit 3 grossen Karten ausser Text. Pp. xxviii + 324. (Berlin: Dietrich Reimer (Ernst Vohsen), 1898.)

Schantung und Deutsch-China. Von Kiautschou ins Heilige Land von China und von Jangtsekiang nach Peking im Jahre 1898. Von Ernst von Hesse Wartegg. Pp. viii + 294. (Leipzig: J. J. Weber, 1898.)

FROM the period of the Jesuit missionaries of the seventeenth century until the present year the bibliography of the Chinese province of Shantung could be printed in a dozen lines; but in the immediate future a flood of Shantung literature will form a conspicuous part of the impending deluge of books on China. The beginning is before us in these richly illustrated volumes, one the work of the most thorough scientific explorer who ever visited China, the other the impressions of a champion globe-trotter. Both books owe their appearance to the lease of Kiauchou Bay recently acquired by the German government, along with extensive rights for the development of the Shantung peninsula. The two prefaces are characteristically in contrast. Baron von Richthofen cautions his readers as to the extreme paucity of trustworthy information, and details the sources whence it can be obtained. The Chevalier von Hesse Wartegg explains that he hastily resolved to see this province for himself, and claims to have visited every place and seen everything in it of any interest whatever to the German public, and all in an amazingly short space of time. The books themselves amplify the contrast. Baron von Richthofen gives an account of his leisurely journey of thirty years ago with the valuable maps which he constructed, and a solid description of the physical structure and economic resources of the province, which, while it will certainly soon be greatly added to by practical explorers, cannot easily be superseded. Von Hesse Wartegg recounts his travels in a gossipy manner, interspersed with notes on the country and people, and copiously illustrated with a wealth of photographs, facsimiles of Chinese proclamations, visiting cards, official stamps and such interesting trifles. He caught the new German territory at the beginning, and describes that beginning with an elaboration of detail which should not weary the patriotic German reader. The rapidity of the journey necessarily detracts from the permanent value of the descriptions of the various towns and places visited, and the work must be looked upon as a sort of "Christmas number" amongst books of travel.

Baron von Richthofen's book merits some furthe notice. Much of it has been published before in the first two volumes of his monumental work on China, the size and price of which have made it a sealed book to most commercial Germans, and the language has presented an even more serious obstacle to the vast usefulness which it should have for the British merchant and student. Parenthetically one cannot help remarking how much an English publisher could serve the interest of his country by producing translations of such works as Richthofen's "China," and resolutely rejecting the sensational jottings of uninstructed tourists, whose writings it is a dreary and discouraging task merely to glance through and throw aside. While the German bar remains to exclude English readers of the class who could most profit by it, the handy form and low price of the new volume will be highly appreciated in Germany. The fact that Baron von Richthofen recognised Kiauchou Bay thirty years ago as a desirable base for German colonial enterprise, is a striking example of the practical value of expert opinion, even though a government be long in acting upon it.

The book contains a valuable introduction dealing with points of practical importance for all interested in China. The section on the European orthography of Chinese names is of great value, and, making allowance for the slight differences in phonetic expressions in German and English, it is no less useful for us than for our neighbours across the North Sea. Baron von Richthofen points out that all Chinese names are made up from a collection of 330 syllables, each represented by a single ideograph which does not vary, although the phonetic and tone value of it differs in each provincial dialect. But while the natives of distant provinces cannot understand each other's speech, they can all not only read the ideographs, but can understand an educated Chinaman speaking the Mandarin dialect—High Chinese, as Richthofen terms it in order to work out a pretty analogy between Chinese and the High German and various local dialects of his Fatherland. All that has to be done is to discover the normal phonetic value of each syllable in "High Chinese," and adopt a definite spelling for it, and the names of all China can then be written with confidence. This, of course, is not published for the first time; but it may be appropriately referred to at present in reference to the adoption in the publications of the Royal Geographical Society of such spellings as *Yang-tse-Chiang* in accordance with Sir Thomas Wade's system of selecting the Peking dialect as the basis for phonetic rendering, whereas the form *Yang-tse-kiang* is the normal one. As so much will be written on China and Chinese affairs in the immediate future, it is really an urgent matter to scientific men, as as well as to merchants and journalists, to fix upon some one mode of spelling which will facilitate reference and prevent confusion. The German forms of Von Richthofen can be adopted in every particular except that where it has *sch* we must write *sh*, and where it has *tsch* we must write *ch* simply. The Germans have adopted *y* in place of their *j*, have the *s* always sharp, and discard the German *z* in favour of *ts*, and they have received the *j* with its French (our *zh*) sound, and the *w* with its English value.

A note on the various grades of Chinese towns explains the meaning of the *-fu*, *-chou*, and *-hsien* attached to the significant part of the name. There is a useful section on weights and measures, in which, however, an error of a decimal point occurs, the length of the *chih* or Chinese foot being given as 3·581 metres according to the British Commercial Treaty. That treaty, however, specifies 14·1 inches as the length of the *chih*, *i.e.* 0·358 metre.

AUSTRALIAN FOLK LORE.

Australian Legendary Tales. Collected by Mrs. K. Langloh Parker. With introduction by Andrew Lang. Pp. xvi + 132. (London: Nutt. Melbourne: Melville, Mullen, and Slade, 1897.)

More Australian Legendary Tales. Pp. xxiii + 104. (London: Nutt. Melbourne: Melville, Mullen, and Slade, 1898.)

AUSTRALIA is still in many respects an unknown country, full of unravelled problems, not the least amongst them being the people who were once the owners of the land. Bit by bit we are getting to know something about the continent, its geology, fauna, and flora; but of its people, beyond their language and physique and complex marriage laws, we know little, and especially is this the case regarding their psychology. This is much to be regretted; but the seeds of the neglect were sown when the first Colonial governments began to sell lands, not their own, to the squatters and settlers to stock with sheep and cattle or for cultivation. But the sheep and cattle ate up the foods which had hitherto been the support of the fauna, upon which the aborigines relied largely for sustenance, so that before long the flocks and herds of the invaders were killed by the hungering natives. The stock-riders and shepherds left to guard the flocks were attacked with a boldness born of ignorance, and reprisals followed with a wantonness and cruelty we would gladly shut our eyes to. In the end the weaker party succumbed and degenerated as we see them in the smaller township of the bush, breeding an undeserved contempt in the minds of their despoilers. Any intercourse of an elevating nature with the Australian was thus nipped at the outset, and hence it is we know so little of the inner life of the doomed people. Fortunately, of late years many good attempts have been made to rescue from loss a very considerable knowledge of the natives, and we have now to record a further attempt, resulting in the publication of two charming volumes, for which we must express our gratitude to the author. For twenty-five years Mrs. Parker has studied the aborigines on the Narran River in New South Wales, close to the Queensland border, discovering practically a new field, for it is the first collection of Australian aboriginal legends we have had the good fortune to meet with. A large number of the stories explain the origin of things according to the native mind—why the cockatoo is bald under his crest, and the lizard covered with prickles; how fire was discovered and stolen; how the Narran lake (? swamp) first made its appearance; and how it is that the pelican has a pouch; how the platypus came to be a cross between a duck and a rat. Much also do we gather about the daily life of the natives: how they prepare their food, hunt the emu, carry on war, and make rain—which latter is sometimes evoked to drown their enemies. In these legends there are ogres and ogresses, who meet with summary justice—some being destroyed by their own means of destruction; human folk climb into the sky as a place of refuge, others are carried there and become stars, some are turned to stone, others see through their noses; their dream spirits get stolen, and one gentleman, to prevent its leaving him, sleeps on his stomach, so that it should not escape from his mouth; there are even underground passages and a moral story, a fragment, of the flies and the bees, which reminds us of the ant and the grasshopper. Poetical justice, too, is not wanting, and in the plan by which Deereeree frightened the widow into marrying him there is a touch of humour. Full of feeling are many of the stories. When the wicked magpie stole the children, "their crying reached the ears of the women as they were returning to their camp. Quickly they came at a sound which is not good in a mother's ears." The legend of Sturt's Desert Pea, the Flower of Blood of the old tribes (*Clianthus Dampieri*), which, when once seen in its rich clusters is never forgotten, is worth reproducing.

Wimbakobolo, a warrior, falls in love with Purleemil, who is otherwise betrothed to the hated Tirlta, and the two take refuge with a friendly tribe. Before the winter had gone a son was born to them, and such a fine little fellow was he that "the tribe laughingly called him 'the little chief,' and brought him offerings of toy boomerangs, throwing-sticks, and such things until the eyes of his mother shone with pride, and the father already began to make him weapons, to be used one day against the enemies of the tribe who had sheltered them. And Purleemil sang new songs, which she said the spirits taught her, about her little son, whom she said was to live for ever, the most beautiful on the plains of the back country. Purleemil would sing her songs, and her baby would crow and laugh, and the father would say little, but bear so proud a look on his face as he glanced, from his carving of weapons with an opossum's tooth, from time to time at his wife and child, that all would smile to see his happy pride, and their hearts were glad that the elders had not given up Purleemil to be the bride of Tirlta." Then the mother, fearing trouble to themselves and 'little chief,' says: "Dark would our lives be without him; he is the sun that brightens our days; without him dark as a grave would they be for ever." But the trouble does come. A night attack is followed by a general massacre. Little chief and his parents are slain, and from their blood arise masses of brilliant red flowers spreading over all. Tirlta revisits the spot to gloat over the slain, and is dazed by the sight before him. Suddenly from the sky a spear transfixes him, and a voice says: "Cowardly murderer of women and children; how dare you set foot on the spot made sacred for ever by the blood that you spilt, the blood of the little chief, his mother and father, which flowed in one stream and blossomed as you see it now, for no man can kill blood, for more than the life of the flesh is in blood. Their blood shall live for ever, making beautiful with its blazing brightness the bare plains, where are the salt lakes, the dried tears of the spirits whose songs Purleemil sang so sweetly, the salt tears which they shed when you, and such as you, poured out the life blood of their loved tribe." So Tirlta was transfixed and turned to stone, but the beautiful red flower lives for ever.

When once it is known that such pretty legends are to be gathered from amongst the Australian natives, there is little doubt but that other friendly squatters and officials will attempt to follow in Mrs. Parker's footsteps. In the meanwhile her two little volumes will certainly run into further editions; and such being the case, we would point out that there are several printer's errors, and that the glossary, excellent as it is, requires further additions. It is doubtful whether an average English reader will know what is meant by a "paddymelon" or a "humpy"—regarding the former word in the story of Mayamah, the printer has placed a comma between paddy and melon! The book is illustrated by some curious sketches made by an untaught local aborigine, supplied by Dr. W. H. Lang of Corowa, about three hundred and sixty miles distant from the Narran. May we ask, did this native ever see any European illustrations before he took to book illustration? Mr. Andrew Lang supplies a preface to each of the two books, in his usual happy strain.

H. LING ROTH.

OUR BOOK SHELF.

The Five Windows of the Soul; or, Thoughts on Perceiving. By E. H. Aitken. Pp. viii + 257. (London: John Murray, 1898.)

READERS of former books by "EHA" will turn with a sense of pleased anticipation to a new work from his pen. They know that they may expect to find a fresh and unconventional setting-forth of various matters of scientific interest, expressed in terse and vigorous English, illuminated by flashes of genuine humour, and accompanied by such comments on the relation of natural phenomena to the ordinary facts of life as suggest themselves to the shrewd intellect of a well-read philosopher and cultivated man of the world. Nor will the present work belie expectation. It is a popular treatise on the five senses—popular in the best acceptation of the word—for it is at once amusing without flippancy, instructive without dulness, and accurate without pedantry. The author has taken evident pains to gather the best and latest information on the subject of the organs of sense; and although it might be possible in a spirit of hypercriticism to point out certain errors and deficiencies, he has in the main succeeded so well that his work ought to mark a distinct epoch in the history of general comprehension and appreciation of the subject. In dealing with the various trains of thought suggested to him by the scientific facts in question, and involving problems of the greatest interest in æsthetics and ethics, he reaches and maintains a high level of literary and philosophical excellence. We should like to commend the whole book, and especially the fourth chapter, to the attention of certain puritan fanatics.

One piece of criticism we must allow ourselves. Mr. Aitken, it is true, could hardly be expected to have made himself acquainted, in time for the production of his book, with the recent striking interpretation of the gradual paling of colour on the under parts of animals. But in some other respects his treatment of the subject of colour is not thoroughly satisfactory, and on p. 219 he seems to steer dangerously close to the "photographic" heresy. Slight blemishes such as these do not, however, detract seriously from the value of a work which represents the honest and successful endeavour of one who is not a professed scientific worker to "see life steadily and see it whole" in its relation to the entire domain of natural knowledge.

F. A. D.

Symbolae Antillanae: seu Fundamenta Florae Indiae Occidentalis. Editit Ignatius Urban. Vol. i. Fasc. 1. Pp. 192. (Berlin: Friedländer, 1898.)

SINCE the publication of Grisebach's "Flora of the British West Indian Islands" in 1859–64, large additions have been made to our knowledge of the native plants, not only of our own West Indian islands, but also of those belonging to other countries. The distinguished Curator of the Imperial herbarium at Berlin has contributed much to this knowledge, but in the form of papers scattered through a number of botanical publications. These he now proposes to collect, and to publish in a connected form, together with hitherto unpublished descriptions of new genera and species, &c. The first instalment, of 192 pages, is occupied entirely with a bibliography of West Indian botany, every work being mentioned which furnishes any information on the native products of the West Indies, whether phanerogamic or cryptogamic, with, where possible, an account of its contents. Every one who has worked at local floras will know how work of this kind is facilitated by a good bibliography; and the thanks of systematic botanists are due to Prof. Urban for the thoroughness with which he has executed this task.

Iowa Geological Survey. Annual Report, 1897, with accompanying papers. Vol. viii. Dr. Samuel Calvin and H. F. Bain. Pp. 427. (Des Moines, 1898).

A LARGE part of this volume is taken up with reports on the geology of Dallas, Delaware, Buchanan, Decatur and Plymouth counties, Iowa. With the survey work referred to, the survey and mapping of twenty-six counties in the State have been completed. In addition to this areal work, special studies of coal, clay, artesian waters, gypsum, lead, zinc, &c., have absorbed a considerable portion of the funds and time of the Survey. As in previous years, close attention was given to the study of problems connected with the drift, and very gratifying progress was made. A paper by Mr. H. F. Bain, Assistant State Geologist, on properties and tests of Iowa building stones, contains much instructive information concerning building stones in general, as well as results of tests of Iowa stones.

In concluding his summary report, Dr. Calvin remarks: "It is gratifying to note the increased use of the reports of the Survey, as works of reference, or works for general study, in high schools and other educational institutions. Progressive teachers have been quick to recognise the educational value of trustworthy tests relating to the physical geography and geological phenomena of regions with which the students are personally acquainted." The reports are thus performing a mission of great educational value to the State.

Numerous plates and half-tone illustrations accompany the papers in the report.

Elementary Mathematics. By J. L. S. Hatton, M.A., and George Bool, B.A. Pp. viii + 356. (London: Whittaker and Co., 1898.)

IT is not often that arithmetic, Euclid, and algebra, are dealt with in a single text-book, and the only reason for their joint appearance in the present volume, is that students working in classes examined by the Science and Art Department may have at hand a means of qualifying themselves for the May examination in Stage I. Mathematics. A knowledge of the fundamental rules of arithmetic is assumed, but numerous examples are given upon them. The Euclid embraces the first Book, with a few additions; and the algebra extends to problems involving simultaneous equations. If only a small proportion of the examples is worked by the student, the dexterity required to pass the examination for which the book is intended will be obtained.

LETTERS TO THE EDITOR.

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

Prof. Meldola's Explanation.

I AM obliged by the courteous expressions of Prof. Meldola's letter, and regret that I should have given him the trouble of writing the latter part of it by not quoting in full a certain passage which I quoted in part: a deficiency of quotation caused by the wish to occupy as little space as possible. As evidence of change in my views, Prof. Meldola takes from "The Factors of Organic Evolution" the following passage:—

"Eventually, among creatures of high organisation, this factor [inheritance of functionally-wrought changes] became an important one; and I think there is reason to conclude that, in the case of the highest of creatures, civilised men, among whom the kinds of variation which affect survival are too multitudinous to permit easy selection of any one, and among whom survival of the fittest is greatly interfered with, it has become the chief factor: such aid as survival of the fittest gives, being usually limited to the preservation of those in whom the totality of the faculties has been most favourably moulded by functional changes" (p. 74).

I now give at length the corresponding passage from the first edition of the "Principles of Biology."

"As fast as the number of organs that co-operate in any given function increases, indirect equilibration through natural selection becomes less and less capable of producing specific adaptations; and remains fully capable only of maintaining the general fitness of constitution to conditions. Simultaneously, the production of adaptations by direct equilibration, takes the first place—indirect equilibration serving to facilitate it. Until at length, among the civilised human races, the equilibration becomes mainly direct: the action of natural selection being restricted to the destruction of those who are constitutionally too feeble to live, even with external aid."

It will be seen that there is no difference between the two, save in form of expression. My belief remains just what it was in 1864.

I suspect that the erroneous impression Prof. Meldola refers to resulted mainly from the ill-judged title "The Inadequacy of Natural Selection." I meant simply to imply that natural selection does not explain all the facts. A better title would have been "Natural Selection a part cause only."

Brighton, January 22. HERBERT SPENCER.

Illusory Resolutions of the Lines of a Spectrum.

DR. PRESTON, in his useful article on Zeeman's phenomenon in NATURE of the 5th inst., has expressed the opinion that some of the resolutions of spectral lines obtained by Michelson's interferometer are illusory (see p. 228). I had occasion some months ago to make use of some of Michelson's results, and came to the same conclusion. In fact, an instrumental resolution of what is in reality a single line may cause it to assume appearances, the principal of which are either a central line with faint appendage lines, or a double line with appendages.

I. *Central line and appendages.*—Let us first consider the illumination produced in the first spectrum by a parallel beam of monochromatic light incident on a grating with $n + 1$ parallel grooves, furnishing n equal and equally spaced reflecting strips between the grooves. This produces in the first spectrum what is usually regarded as a line in a position which we may call A, but what is really a distribution of light along the whole spectrum, having (if the slit be of infinitesimal width) positions of cypher intensity at short intervals, and having a maximum of illumination between every two consecutive positions of cypher intensity.[1] The intensities of these maxima are such that one of

[1] If the light is incident perpendicularly on a flat grating with n reflecting strips, the principal maximum illumination in the first spectrum occurs in the direction A, which makes, with the normal to the grating, an angle θ, such that $\sin\theta = \lambda/\sigma$, where λ is the wave-length of the monochromatic light, and σ the spacing of the reflecting strips of the grating. In the directions $\theta + \delta\theta$, where $\delta\theta = k\frac{\tan\theta}{2n}$, the illumination is 0 if k is an even integer, and a maximum if k is an odd integer: and the intensities are as stated in the text. Similar results come out when the incident light reaches the grating in other than the perpendicular direction, or when the grating is concave instead of flat.

them surpasses all the others, and has an intensity which we may call I. It is situated in the direction A. The next maxima, one on either side of the principal one, have intensity I′/9, where $I'/I = 4/\pi^2$; the next pair beyond these have intensity I′/25; and so on—the intensities of the lateral maxima decreasing inversely as the squares of the odd numbers. These are consequences of the theory of diffraction gratings. From the above law it follows that the maxima soon become much too faint to be seen by the eye, or to affect a photographic plate, so that what alone can be made visible is the group in the immediate neighbourhood of the position A. This group is what seems to be represented on a very large scale in some of Prof. Michelson's figures, but which in our spectroscopes is so compressed laterally that the whole group appears like one line.

A similar group is necessarily substituted for each physically single line wherever there is one of those limitations of aperture which must occur within the interferometer itself, and, in fact, in every optical instrument. In the astronomical telescope it occasions the spurious disc of a star with its attendant rings. The only question is whether the intervals between the maxima of the group are sufficiently wide to be detected by the interferometer; and as this is simply a question of aperture, or, in the case of a grating, of the number of rulings, it follows that these instrumental groups may be distinguished from physically real groups by the circumstance that the maxima present in them will become more widely spaced if the aperture (or number of rulings) is reduced.

II. *An apparently double line.*—Where the apparatus employed limits the aperture at only one place, the group, which will be substituted for a physically single line, is that described above; at least, if the instrument is in adjustment. But if the arrangements are such as to introduce an actual or virtual limitation of apertures at two places, a double line may result, accompanied by faint appendage lines. What then occurs was discussed in a communication made by the writer to the British Association in 1894 (see Report of the Oxford meeting, p. 583; when also were exhibited examples of such spurious double lines coarse enough to be seen without an interferometer, and where the appendage lines predicted by theory were also seen when the light was intense.

The foregoing instrumental effects arise when the apparatus is accurately collimated. If it be much out of adjustment the groups, substituted for a really single line, are more complicated. But whatever they may be, it is certain that if the resolving power of the interferometer can go sufficiently far, it will bring them into view if they are sufficiently bright to be seen, and that we must then be on our guard against mistaking a resolution of this kind for evidence that the line under examination is physically multiple. G. JOHNSTONE STONEY.

8 Upper Hornsey Rise, N., January 13.

THE remarks put forward by Dr. Stoney are the well-known results of the wave theory, and Prof. Michelson, no doubt, is quite familiar with all that has been said in this department. In addition, he alone is quite familiar with what it is that is actually observed in his interferometer, and therefore must be in a position to give a strong opinion as to whether the observed effects are spurious and due to diffraction or not.

It was with this feeling that I wrote my remarks (p. 228), and I wished to draw some further information from Prof. Michelson on this important subject, rather than in any way to cast doubt on the correctness of his conclusions. I have never worked with the interferometer, and therefore cannot pronounce upon its performance as an optical instrument, but I trust Dr. Stoney's interesting and important observations may have the effect of drawing a full explanation of all the outstanding difficulties.

Bardowie, Orwell Park, Dublin. THOMAS PRESTON.

A Note on Catching Insects, and the Behaviour of the Bulldog-Ant of South Australia.

DURING my visit to South Australia, I wished to obtain some specimens of the insects of the country, for my naturalist friends at home. At first I experienced considerable difficulty in catching those whose movements were rapid, without injuring their bodies. Recently I have been able to secure nearly every specimen seen, by the following method.

A small antitoxin syringe was charged with benzol, and a small jet of the liquid was directed towards the beast sought for (a large tarantula, for example); the result of this form of attack was to render the beast almost instantly inert, so that it was easily secured. I am not at all sure that benzol is the best liquid for the purpose; but I used it, as it happened to be the only substance I could obtain, at a distance from a township, which appeared likely to produce the desired effect. I find that insects which could be easily captured a month ago when it was fairly cool, have become wonderfully active now that the sunshine temperature is about 150° to 155° F.

I placed a large bulldog-ant, about one inch in length, in a glass bottle three and a half inches in diameter; I noticed that when the bottle was on its side, and the ant was clinging to the upper surface of the bottle, with its back pointing downwards, that if the ant was detached by a slight jerk, it fell on its feet. I repeated this experiment many times, with seven different bulldog-ants; in every case the ant fell feet downwards, after the well-known manner of a cat.

As I am no naturalist, I may be describing an acrobatic movement of the bulldog-ant already well known to students of natural history. But even should this be so, probably the fact I have mentioned may be of interest to others.

FREDK. J. JERVIS-SMITH.

Quanbi, Mt. Barker, South Australia, December 16, 1898.

A New Dome for Equatorials.

WITH reference to the note in NATURE of January 12 (p. 257), on "A New Dome for Equatorials," allow me to point out that a rotary dome without a shutter was, as far as I know, first constructed for the observatory in Strassburg. The late Prof. Winnecke, at the meeting of astronomers in Berlin on September 5, 1879, referred to it as follows (*Vierteljahrsschrift der Astronomischen Gesellschaft*, 14 *Jahrgang*, p. 334): "In consequence of the construction of the altazimuth, in which the telescope was placed at the end of the axis, the dome of the north tower had to have an unusually large aperture. This was easily accomplished by employing two separate halves of a hemisphere, which could be rolled back on wheels situated above the circular rail, by which means a complete aperture of 2½ metres could be obtained. The mechanism for the movable parts works easily and surely."

The same construction is described in the *Annalen der Kais. Univ. Sternwarte in Strassburg*, vol. i. p. 7; an illustration of this will be found on Plate vii. (the dome to the left): although both domes—that to the right holding a small refractor, viz. a comet-seeker—are represented as closed, the difference can be seen at once.

I trust that this short historical remark may be mentioned in the next number of NATURE. E. BECKER.

Kais. Univ. Sternwarte, Strassburg, i. E., January 15.

Luminosity of Sugar.

THE communication of Mr. J. Burke to the British Association, on the luminosity of sugar (NATURE, vol. lviii. p. 533) recalls to my mind an illustration on the large scale of the same interesting phenomenon.

In the process of making what is known as granulated sugar, ordinary refined sugar is passed through a revolving sheet-iron cylinder, where it meets with a current of hot air, and is warmed and dried at the same time. On leaving the drying cylinder the sugar is taken by a travelling band, or other carrier, and dropped into a hopper, from whence it is drawn for packing. The sugar falling into the hopper soon forms a pyramidal heap, and when this is examined in darkness, the top of the heap, where the stream of sugar lands, is seen to glow with a steady light blue luminosity.

On rubbing two pieces of ordinary lump or tablet sugar together, in darkness, the glow is readily produced, and when a piece is broken in two there is a bright flash at the moment of fracture. The light produced in this manner is not affected by moistening the lumps with alcohol, but is intensified when water is used.

When hard lumps of sugar are crushed by striking with any solid body, such as a shovel, the glow appears as a flash, and is easily seen even in the presence of dull light, but is, of course, best viewed in complete darkness. Even a heap of loose sugar responds to a blow from a shovel.

Sometimes sugar, as purchased retail, when left in the bag during dry weather, sets to a hard mass. On scraping such with a spoon or such-like article the light is readily produced, and when two such masses are rubbed together a very strong glow is the result. THOS. STEEL.

Colonial Sugar Ref. Co., Ltd., Sydney, N.S.W.

The Wanton Destruction of Rare Visitants to our Shores.

IN the *Zoologist* for this month (No. 691) is recorded the destruction and capture of the following rare bird visitants to our shores:—Six crossbills, one goshawk, one flamingo, one little bustard, one great shearwater, one avocet, and two Sclavonian grebes. Is it not time this senseless and unwarrantable destruction of these beautiful creatures ceased? Will you, as the leading scientific journal, lift up your voice against it, and earn the gratitude of every lover of nature?

Rottingdean, Sussex. E. L. J. RIDSDALE.

EXPERIMENTS ON THE AUTUMN COLOURING OF PLANTS.

THOUGH in the course of the present century a good deal has been written as to the causes of the autumn tints of leaves, our knowledge of this subject is still in a very unsatisfactory condition. The following notes may serve to show the nature of some of the principal factors involved.

While engaged on some osmotic experiments in the summer of 1897, I made the observation that the newly-formed leaves of specimens of *Hydrocharis morsus-ranae*, which had been placed some days previously in a weak solution of cane-sugar, assumed a rich reddish-brown colour, although otherwise perfectly normal. Further experiments showed that the culture of this plant in solutions of cane-sugar, grape-sugar and fructose constantly has this effect on the colouring of those leaves which are developed during the sojourn of the specimens in these solutions, and that even the leaves which were fully developed before the commencement of the experiments gradually become of the same reddish-brown hue.

This colour is due to the appearance of red cell-sap in the palisade-cells, and in the cells lining the air-chambers of the leaf. A certain number of these cells often contain red cell-sap under normal conditions, especially if the plants are strongly insolated, and the temperature of the water in which they are living is somewhat low; but under these conditions, the leaves never assume a colour approaching to that of plants cultivated in sugar solutions. If the sugar solutions are changed often enough, the plants remain perfectly healthy for weeks, and multiply rapidly by means of suckers. In one set of experiments I have followed the development during four successive generations.

In specimens of Hydrocharis grown in a good light the leaf-stalks, suckers and roots are usually more or less dotted with red under normal conditions; but the number of cells containing red cell-sap is very much increased in these parts of the plant, if the specimens are cultivated in a sugar solution, even though the conditions of light and temperature are much less favourable for the production of the red pigment than in the specimens grown in pure water.

Salt solutions and the solutions of organic compounds other than the carbohydrates have no such effect on Hydrocharis, and even among the sugars galactose is entirely without effect. Lactose acts only after a long period, and the effect is even then very slight and is probably due to hydrolysis.

A few experiments with *Lemna minor* and with *Potamogeton perfoliatus* in solutions of various sugars not leading to similar results, I should probably have laid the whole subject aside, had not my attention shortly afterwards been drawn to the red-colouring of plants in general by a tour in the Upper Engadine just at a time when the autumnal colouring of the Alpine plants was reaching its climax.

There, among the magnificent tints that overspread the mountain slopes, my mind naturally reverted to my laboratory experiments and the possibility of a correlation between the two sets of phenomena suggested itself. Observations and experiments, made upon the spot, led me to the conclusion that there were good grounds for the conjecture that an increase of sugar at the cost of starch might be *one* of the factors concerned in the formation of the red pigment of those leaves which become red in autumn.

Of such leaves there are two distinct classes. The one set comprises the perennial leaves, and those leaves which, formed during the later part of the summer, remain alive till the following spring or summer. This set of leaves (with the exception of those which die in spring) lose their reddish hues with the return of warmer weather (*e.g.* holly, ivy). The other set comprises those leaves which fall and die soon after attaining their reddish tints.

Lidforss[1] has drawn attention to the fact that during the winter the leaves of our native plants are entirely devoid of starch, but contain large quantities of sugar. Without a previous knowledge of Lidforss' paper, I obtained the same results and found that the deciduous leaves at the time they assume their autumn tints contain more sugar and less starch than in midsummer.

The remarkable coincidence of the appearance of red cell-sap with the increase of sugar in autumn and its disappearance in spring at a time when the greater part of the sugar in the leaf is recondensed to starch, together with my observations on Hydrocharis, formed the starting point for a considerable number of experiments on the formation of the red pigment of leaves.

These experiments and observations have led me to conclusions which may be stated broadly thus:—

The red colouring matters of green plants are probably of the nature of glucosides, and are in most cases unions of tannin compounds with sugar.

The chief physical factors in their production are: (*a*) sunshine, which on the one hand augments assimilation and the production of sugar, and on the other hand accelerates the chemical process leading to the formation of the pigment; and (*b*) a low temperature, which prevents the conversion of the sugar into starch. In other words, the red autumnal tints are in great measure the direct result of the autumnal climatic conditions.

It is possible in many plants to produce (red) autumnal tints at any time of the year, by feeding them with glucose.

Generally speaking, this artificial production of red cell-sap is possible only where the natural reddening of the leaf has its seat in the mesophyll cells. In cases where the coloration is in the epidermis, experiments with glucose are unsuccessful.

Among plants especially favourable for experiments on the artificial production of red cell-sap, I may mention various species of *Lilium* (*L. Martagon*, *L. candidum*, *L. umbelliferum*), Holly (*Ilex aquifolium*), various succulent plants, such as *Saxifraga crassifolium*, and among water-plants, besides *Hydrocharis*, the different indigenous species of *Utricularia*.

A full account of these experiments, together with their connection with various phenomena of plant-life, will appear shortly in the *Jahrbücher für wissenschaftliche Botanik*. E. OVERTON.

THE GREAT CATALOGUE OF BIRDS.

THE recent issue of the twenty-sixth volume of the "Catalogue of Birds in the British Museum"[2] (the twenty-seventh and concluding volume having been published in advance in 1895) brings to an end a

[1] *Botan. Centralblatt*, Bd. 68. p. 33-44 (1896).

[2] "Catalogue of the Plataleæ, Herodiones, Steganopodes, Pygopodes, Alcæ, and Impennes in the Collection of the British Museum." By R. Bowdler Sharpe and W. R. Ogilvie-Grant. (London, 1898.)

formidable task, commenced in 1874, which has occupied the time and energies of some of the leading ornithologists of the present day during the past twenty-five years. For it must be recollected that this work, although modestly entitled a "Catalogue of the Birds in the British Museum," is far more than a mere list of specimens. It gives, in fact, besides a list of the specimens in the British Museum, an account of all the known species of birds, embracing their synonyms (*i.e.* the various names which have been applied to them by different authors), descriptions of their various plumages, their countries and all other necessary information concerning them. Such a work, although it has been attempted on several occasions, has never been brought to a conclusion since Latham completed his "General History of Birds" in 1824. And in Latham's days, it should be remembered, a general history of birds was a comparatively easy matter. Latham was acquainted with only some 4300 species of birds, which he grouped in 112 genera. The British Museum Catalogue gives us an account of 11,617 species of birds, arranged in 2255 genera, showing that our knowledge of the class Aves has increased nearly three-fold since 1824.

The "Catalogue of Birds" was commenced in 1874, and finished in 1898. As completed, it forms twenty-seven octavo volumes, varying in extent from 300 to 800 pages each, and illustrated by numerous coloured plates. We give a list of the authors, contents, and dates of issue.

Vol.	Contents.	Author.	Date.	No. of Genera.	No. of Species.
I.	Accipitres	R. B. Sharpe	1874	80	389
II.	Striges...	R. B. Sharpe	1875	19	190
III.	Coliomorphæ	R. B. Sharpe	1877	94	370
IV.	Cichlomorphæ, Pt. I..	R. B. Sharpe	1879	81	520
V.	Cichlomorphæ, Pt. II.	H. Seebohm	1881	18	344
VI.	Cichlomorphæ, Pt. III.	R. B. Sharpe	1881	66	407
VII.	Cichlomorphæ, Pt. IV.	R. B. Sharpe	1883	164	687
VIII.	Cichlomorphæ, Pt. V., and Certhiomorphæ	Hans Gadow	1883	46	402
IX.	Cinnyrimorphæ ...	Hans Gadow	1884	35	355
X.	Fringilliformes, Pt. I..	R. B. Sharpe	1885	63	448
XI.	Fringilliformes, Pt. II.	P. L. Sclater	1886	100	575
XII.	Fringilliformes, Pt. III.	R. B. Sharpe	1888	101	559
XIII.	Sturniformes	R. B. Sharpe	1890	129	601
XIV.	Oligomyodæ	P. L. Sclater	1888	142	665
XV.	Tracheophonæ ...	P. L. Sclater	1890	92	531
XVI.	Upupæ and Trochili.. / Coraciæ	O. Salvin ... / E. Hartert...	1892	163	687
XVII.	Coraciæ (*continued*) and Halcyones ... / Bucerotes and Trogones	R. B. Sharpe / W. R. Ogilvie Grant ...	1892	67	397
XVIII.	Scansores	E. Hargitt...	1890	50	385
XIX.	Scansores and Coccyges...	P. L. Sclater and G. E. Shelley ...	1891	87	448
XX.	Psittaci	T. Salvadori	1891	79	499
XXI.	Columbæ	T. Salvadori	1893	68	415
XXII.	Pterocletes, Gallinæ, Opisthocomi, Hemipodii	W. R. Ogilvie Grant	1893	94	426
XXIII.	Fulicariæ and Alectorides	R. B. Sharpe	1894	88	252
XXIV.	Limicolæ	R. B. Sharpe	1896	102	255
XXV.	Gaviæ ... ... / Tubinares	H. Saunders / O. Salvin ...	1896	46	224
XXVI.	Plataleæ, Herodiones, Steganopodes, Pygopodes, Alcæ, and Impennes	R. B. Sharpe and W. R. Ogilvie Grant ...	1898	98	290
XXVII.	Chenomorphæ, Crypturi, and Ratitæ ...	T. Salvadori	1895	83	296
				2255	11,617

The Catalogue was commenced in 1872 by Dr. R. Bowdler Sharpe, soon after he had succeeded the late George Robert Gray in the charge of the national collection of birds. To the late Dr. John Edward Gray, then Keeper of the Zoological Department, must be ascribed the credit of starting it, though he only lived to see the first volume brought to completion. This was issued in 1874, and contained an account of the diurnal birds of prey; it was followed in 1875 by the second volume, also prepared by Dr. Sharpe, devoted to the owls. After this Dr. Sharpe proceeded to attack the long array of Passeres, an order which embraces rather more than half the whole number of known birds, and got out two volumes on the subject in 1877 and 1879. The late Henry Seebohm—a distinguished traveller and ornithologist—one of whose pet groups was the thrushes and their allies, was then invited by Dr. Günther, who had succeeded Dr. Gray in the keepership of the zoological department, to prepare the catalogue of this family. Seebohm produced it in 1881, after what, he tells us, was "two close years of application" to a very difficult task. Meanwhile Dr. Sharpe was working away at other groups of the great Passerinie Order, and succeeded in issuing two more volumes (vols. vi. and vii.) in 1881 and 1883. By this time, however, Dr. Günther had quite satisfied himself that if the Catalogue of Birds was to be finished within a reasonable period it would be necessary to obtain further aid from outside. The task was far too vast for the unassisted efforts of a single ornithologist, who had, moreover, the charge and arrangement of the enormous national collection of birds on his shoulders, however hard he might work. Failing to find any qualified British ornithologist with leisure to help him, Dr. Günther naturally turned to Germany, and invited the aid of Dr. Hans Gadow (now settled at Cambridge), to whom we are indebted for the compilation of vols. viii. and ix. of the "Bird-Catalogue." Dr. Günther also managed to persuade Mr. Sclater, the Secretary of the Zoological Society, who was the possessor of a very full series of American birds, not only to part with them in favour of the national collection, but also to undertake to prepare the catalogues of some of the groups that he had made the special subjects of his studies. It thus came to pass that three volumes of the catalogue of Passeres, and half of a fourth volume relating to the Scansores, were written by Mr. Sclater. The very difficult and laborious task of cataloguing the humming birds (Trochilidæ), with some 500 species, was in the meanwhile entrusted to the late Mr. Osbert Salvin, and, we need hardly say, was most efficiently performed by that accomplished and accurate naturalist. Mr. Hartert (of the Tring Museum) joined forces with Mr. Salvin, and contributed an account of the swifts and goat-suckers to the same volume, which forms the sixteenth of the series. Another expert—the late Mr. Hargitt, was employed on the catalogue of woodpeckers (vol. xviii.)—a group to which he had paid special attention, while Captain Shelley undertook the cuckoos, Count Salvadori the parrots and pigeons, and Mr. Ogilvie-Grant the game-birds—groups with which, in each case, the authors were already respectively familiar. In this way, at the end of 1893, twenty-two volumes of the Catalogue had been brought to a conclusion, and only five more remained to be accomplished. Some little difficulty, we believe, was experienced by Dr. Günther in allocating these five volumes in a satisfactory manner, but Mr. Howard Saunders, our chief authority on the Laridæ (gulls and terns), was obviously the proper person to undertake their enrolment in the national catalogue, and at the same time his most valuable private collection of these birds was secured for the Museum. Nor was it less obvious that the late Osbert Salvin was the person to whom the charge of the petrels, a very difficult group, of which he had long made a special study, should be assigned. Both these selections were most satisfactory, and the result was that vol. xxv., produced by the joint efforts of these two ornithologists in 1896, is one of the best of the long series. At the same time the veteran systematist, Count Salvadori, of Turin, undertook the final volume (xxvii.), containing the Anseres (ducks and geese), the tinamous and the ostriches;

and the three remaining volumes (xxiii., xxiv. and xxvi.) were assigned to the hard-worked officials of the British Museum. Of these Dr. Sharpe got out one in 1894, and another in 1896. The twenty-sixth volume, of which the first half was prepared by Dr. Sharpe, and the second by Mr. Grant, has now just made its appearance, and renders the long series of twenty-seven volumes complete.

Taking this laborious piece of systematic work as a whole, there can be no question, we think, of its value. This has been indeed acknowledged by naturalists all over the world, whose anxious inquiries for many years have been as to the prospects of its being brought to a conclusion. The variation in treatment of the different portions of the work, caused by the idiosyncracies of the eleven ornithologists who contributed to its composition, was of course unavoidable. No one person could have accomplished the task, and a wise discretion on minor points was left to those who helped in its composition. Some of them have made many generic divisions, others few. Some have written long descriptions, others short ones. Some have employed one set of rules of nomenclature, others have followed another code. Greater uniformity on all these points would, of course, have been very desirable. But it was practically unattainable, and its absence has scarcely diminished the usefulness of the whole series. During its progress, however, great additions have been made to our knowledge of many of the groups, especially to those treated of in the earlier volumes. From Sir William Flower's preface to the twenty-sixth volume we are pleased to learn that a supplement, containing references to every species of bird described subsequently to the publication of the volume which treats of the group to which it belongs, is in preparation, and will be accompanied by a general index. This will be a most valuable addition, and will serve to render the vast stores of ornithological lore comprised in the twenty-seven volumes of the "Great Catalogue of Birds" still more useful to future workers. Those who have planned and those who have carried out this important undertaking alike deserve the grateful thanks of all zoologists.

SIGNS OF PROGRESS IN SCIENCE TEACHING.

DURING the past Christmas vacation, London, Manchester, Shrewsbury and other places have been astir with educational conferences. These have been attended by teachers of all ranks. The College of Preceptors held a gathering which lasted a fortnight, with daily morning and afternoon sessions, including a conference of science teachers organised by the Technical Education Board of the London County Council. These conferences have dealt not only with questions of organisation, but largely with the subjects to be taught, and the methods of teaching them. The increasing interest in the movement is also indicated by the appearance of new educational journals, in addition to those that already occupy the field. One of these, *The School World*, has special reference to modes of instruction, together with articles on different departments of the subject by good writers of the advancing school. Progress is also shown by the much more general introduction of the teaching of science. The public elementary schools have mostly introduced science into their scheme of instruction, and it occupies a more and more worthy place in their time tables. All the great public schools include some amount of science in their curriculum. The universities of course have professorships of various sciences, and these are better attended by students than formerly. The intermediate schools, which are under private management, are following suit, though in very various degrees.

But what is the teaching of science? The time is past for the chemistry lesson to consist merely of the precipitation of the highly coloured chromates or iodides, and the explosion of oxygen and hydrogen; or to appear as "la chimie amusante" in the prospectus of a young ladies' school. It is perhaps generally recognised that physics and chemistry cannot be taught merely from text-books; that would be uninteresting, and scarcely instructive. Nor must the teaching depend solely upon showy demonstrations on the lecturer's table. These may be attractive, but they often leave only a confusion of ideas in the mind of the student. There is a great tendency now to recognise that the pupils should not only read descriptions of objects, but see and handle them; not only watch experiments, but perform them. There is a movement in many quarters to adopt the "Heuristic" method, so strongly advocated by Prof. Armstrong, by which the student is led to find out results or causes for himself, and to express them intelligently in writing. This is a truly educational method; but it has its limitations. One of these is the amount of time that can be given, as from the very nature of it this must be a slow process: another is that the teacher ought himself to suggest certain lines of research, and watch over the student's progress, directing him unconsciously towards the right conclusions.

In this transition period there are two practical difficulties. First, the want of teachers sufficiently imbued with the new methods to carry them out successfully. Secondly, the examination which usually forms a necessary part of the student's career. This examination is generally founded more upon the old than the new methods, and is directed to ascertaining the amount of the student's knowledge rather than the discipline which his mind has received. It is important to bear in mind what is the chief object in view; not so much to teach a specific science as to indoctrinate the student in the principles which underlie all science, and which will be of essential service to him in whatever calling he may afterwards engage: not so much to store his mind with facts, as to develop his faculties—his powers of observation and reasoning. In bringing about such a reform the practical teacher may often find it necessary to proceed, not by a sudden revolution, but by gradual modifications and improvements in method.

J. H. GLADSTONE.

PROFESSOR ALLEYNE NICHOLSON.

TO all students of zoology (in its most extended sense) the name of Alleyne Nicholson is so familiar, that the recent announcement of his premature death will probably have caused a sense of personal loss even to those who never enjoyed the pleasure of his acquaintance. By those who did know him personally, the general charm of his manner, and his enthusiasm for his favourite science, will not readily be forgotten.

Henry Alleyne Nicholson was born at Penrith, Cumberland, in the autumn of 1844; his father being Dr. John Nicholson, who gained considerable distinction as a linguist and philologist, especially in Oriental literature. The son was educated first at Appleby Grammar School, subsequently at Göttingen, and finally at the University of Edinburgh. At the latter University he gained the Baxter Natural Science Scholarship; and when only twenty-five he was appointed (in 1869) Lecturer on Natural History in the Extra-Mural School of Medicine in that city, an appointment which he held till 1871, when he became Professor of Natural History and Botany in the University of Toronto. He did not, however, remain long at the latter post, moving to Durham in the same capacity in 1874; while one year later (1875), he accepted the

Natural History Professorship at St. Andrews. This post he held till 1882, when he was appointed Regius Professor of Natural History in the University of Aberdeen; and here he died in harness, respected and esteemed alike by colleagues and pupils. The degrees of M.D. (Edinburgh) and D.Sc. he took in due course; and he was also Ph.D. of Göttingen. In 1888 he was the recipient of the Lyell medal from the Geological Society. He also held the Swiney Lectureship in Geology from 1877 to 1882, and a second time from 1890 to 1894, when it had come under the direction of the Trustees of the British Museum. He was elected a Fellow of the Royal Society in 1897.

Although his life's work covered a very wide field, perhaps Nicholson's best claims to distinction will rest on his researches into the structure and affinities of the Stromatoporoids and the Graptolites. But, although all his conclusions did not meet with general acceptation, it would be unfair not to mention also his works on the Monticuliporoids and the Palæozoic Tabulate Corals. And here it should be observed that, through no fault of his own, his investigations of these latter groups took place a little too early; so that when the results of the *Challenger* discoveries became known, several modifications of view were rendered necessary. The older rocks of the Lake District likewise claimed a large share of his attention; many of his summer vacations being diverted, with a genial companion, to the elucidation of the difficult problems they present. His claims to distinction as a palæontological student of the lower Invertebrates are recognised by the dedication to him of the recently described *Millestroma Nicholsoni*. The important part he played in determining the rock-succession in the Lake District must not be forgotten in estimating his achievements. Nicholson's most widely-known monument will, however, undoubtedly be the large series of zoological and palæontological text-books, which have rendered his name a household word in every science-school and university where the English tongue is spoken. These had but comparatively humble beginnings; and it is to the credit of their author that, as they acquired a wider and wider reputation, he rose to the occasion by endeavouring to bring the later editions to a higher level than that on which he had started. Whether the plan of separating palæontology from zoology proper is the best that could have been devised, or the one likely to be followed in the future, this is neither the place nor the occasion to enquire. But, from a student's standpoint, it may be admitted that the first volume of the last edition of his "Palæontology" is almost the ideal of what a text-book should be. Personally, we knew him as a teacher only by a too brief portion of his last series of Swiney lectures; but, apart from the testimony of those who have enjoyed more favourable opportunities, his books are sufficient to proclaim how admirably suited he was for the important position he occupied with so much distinction.

The University of Aberdeen will have no easy task to secure a worthy successor! R. L.

NOTES.

A FULL biography of the Polish philosopher Hoené-Wronski has been in preparation during the past seven years. Wronski resided in London in 1820–22, and Mr. Zenon Przesmycki, who has the work in hand, would be very grateful for any further information, or access to correspondence, bearing on Wronski's life during that period. Mr. Przesmycki was in London last summer, and through the kindness of the authorities of Greenwich Observatory, the Admiralty, Royal Society, British Museum, and Record Office, he was able to consult various important documents. But no trace was found of a paper ("Réforme de la théorie mathématique de la terre") of his, presented to the Royal Society in June 1820, by the hands of the Astronomer Royal, Mr. Pond, nor of two printed extracts of this paper which Mr. Pond was authorised by the Society to make; their titles being (1) "Extrait du mémoire de M. Hoené-Wronski sur la théorie de la terre"; (2) "Nouveaux extraits du mémoire de M. Hoené-Wronski et de son appendice, principalement sur la théorie des fluides, 1821." The publication now of these facts, and that when in London Wronski corresponded frequently with Pond, with the mathematician Davies Gilbert, with the Rev. Mr. Nolan, and with Lord Melville, then First Lord of the Admiralty, and that he resided in Thiot's Hotel, at 15 Bucklersbury Square, may help to the discovery of further particulars. Dr. Alexander Galt, of Glasgow University, will be glad to receive, for Mr. Przesmycki, any information upon these matters.

AT its annual meeting, on January 10, the Russian Academy of Sciences awarded its Helmersen premium to A. Mickwitz for his work, "Die Brachiopoden. Gattung *Obolus*, Eichwald"; the Lomonosoff premium to N. I. Andrusoff for his work, "The fossil and the living *Dreissenidae* of Eurasia"; to E. Burinsky, for his improvements in photography; and to P. I. Brounow, for his works in meteorology. The large Tolstoi medal was awarded to L. Besser and K. Ballod, for their researches into the natality and mortality of the populations of European Russia, the Baltic provinces, and different countries of Europe, including Great Britain; and the small medal to P. G. Matsokin, for a MS. work on the half-breeds of Transbaikalia.

PROF. RAY LANKESTER makes the welcome announcement that arrangements have been made for the supply of electric lighting to the Natural History Museum, South Kensington. The electric light will be gradually introduced into the various parts of the building—first of all into the offices and studies of the staff and the workshops in the basement, and then into the various public galleries.

HERR J. BORNMÜLLER starts this month on a botanical expedition to the less-known mountains of Northern Persia.

DR. DON FRANCISCO P. MORENO, director of the La Plata Museum, and commissioner of the Argentine Republic in the boundary delimitation with Chile, has arrived in London from Buenos Ayres.

WE regret to read, in the *Athenaeum*, that, in a fire which broke out in the physical laboratory of the University of Geneva, Prof. Chodat has lost the whole of his valuable herbarium, together with two hundred botanical drawings, the result of ten years' labour. A large number of botanical specimens, lent by other institutions, have also been destroyed.

A SERIES of lectures will be delivered in the Lecture Theatre of the South Kensington Museum on the following Saturdays, at 3.30 p.m.:—January 28 and February 4, Dr. W. J. S. Lockyer, "Astronomical Instruments"; February 11 and 18, Mr. J. H. Pollen, "Furniture"; February 25 and March 4, Mr. William Burton, "Pottery."

THE Nicaragua Canal Bill has passed the U.S. Senate. The Bill provides for the construction of the canal by the present Nicaragua Maritime Canal Company. The United States will control the canal, and own all the stock except 7½ per cent. given to Nicaragua and Costa Rica. Each of these will have one director, the United States appointing five. The neutrality of the canal is guaranteed by the United States. The canal is to be used by all nations at equal tolls. It is to be completed within six years. Its cost is limited to 115,000,000 dollars, and not more than 20,000,000 dollars are to be expended annually.

Science announces the death, at Philadelphia, of Dr. E. Otis Kendall in his eighty-first year. Dr. Kendall was for more than fifty years professor of mathematics in the University of Pennsylvania, though recently he had relinquished active duties. He had also held the chair of Astronomy in the University, and was for a long time dean of the scientific department, and was in 1883 elected vice-provost, being honorary vice-provost at the time of his death. Dr. Kendall was for twenty-eight years one of the secretaries of the American Philosophical Society, and for the following twenty-one years one of its vice-presidents. He was the author of a text-book of astronomy and of various contributions to mathematics, as well as of computations for the U.S. Nautical Almanac and the U.S. Coast and Geodetic Survey.

THE death is announced of Dr. Joseph Coats, professor of pathology in the University of Glasgow. Dr. Coats was born in 1846, and he received his preliminary education at Paisley and his medical education at the Universities of Glasgow, Leipzig, and Würzburg. He was appointed editor of the *Glasgow Medical Journal* in 1878, and was degree examiner in pathology 1879–82, lecturer on pathology 1890–94, and professor of pathology since 1894 at the University of Glasgow. He was president of the Pathological Society in 1876, and president of the Medico-Chirurgical Society in 1891. He was the author of several medical works, and he also contributed numerous papers to the various learned societies and medical journals.

THE Paris correspondent of the *Lancet* reports that Dr. Dumontpallier has died at the age of seventy-four years. He was a member of the Academy of Medicine, president of the Society of Biology, an Officer of the Legion of Honour, and was for many years physician to the Hôtel Dieu. Of recent years he has been best known by his researches into hypnotism and hypno-therapeutics, in which he had a great belief.—The death is also announced of Dr. Camille Dareste, professor at the Paris School of Anthropology. He was best known for his researches in embryology, and was practically the founder of the science of experimental teratology, while his researches on the artificial production of monsters created very widespread interest. He was formerly the professor of medicine at Lille, and some fifteen years ago went to Paris as director of the school for higher education.

A SERIES of severe earthquake shocks occurred in some parts of Greece on Sunday morning. The *Times* correspondent at Athens reports that nearly the whole Peloponnese was visited by the disturbance. Severe shocks were felt at Corinth, Megara, Tripolis, Sparta, Gythium, Patras, and Pyrgos, but little damage was done at these places. Messenia, however, experienced the full force of the earthquake, and, besides considerable destruction of property in the towns of Philiatra and Kyparissia, two or three neighbouring villages are reported to be in ruins or uninhabitable. Prof. Milne states that the earthquake reached the Isle of Wight at 8h. 24m. 55s. on Sunday morning. There were preliminary tremors for three minutes, and then three shocks, followed by the usual echoes or reverberations, three in number.

THE Swiney Prize for the present year has been awarded to Dr. J. Dixon Mann, Professor of Forensic Medicine and Toxicology at Owens College, Manchester, for his book on "Forensic Medicine and Toxicology." The prize, in accordance with the will of the testator, is awarded on every fifth anniversary of his death to the author of the best published work on jurisprudence. It consists of a silver goblet of the value of 100*l.*, with money to the same amount. Dr. Swiney died fifty-five years ago, and the award has been regularly made every fifth year to the present time. The Society of Arts are the trustees of the fund, and the award is made by that Society and the Royal College of Physicians. Having regard to this fact, the prize has up to the present date been given alternately for works on general jurisprudence and on medical jurisprudence.

A MEETING of the Institution of Mechanical Engineers will be held on Thursday and Friday, February 9 and 10, at the new house of the Institution, Storey's Gate, St. James' Park. The chair will be taken by the president at half-past seven p.m. on each evening. The annual report of the council will be presented to the meeting on Thursday, and the annual election of the president, vice-presidents, and members of council will take place on the same day. The retiring president, Mr. Samuel W. Johnson, will induct into the chair the president-elect, Sir William H. White, K.C.B., F.R.S. The following papers will be read and discussed, as far as time permits:—Fifth Report to the Alloys Research Committee: Steel, by Prof. Roberts-Austen, K.C.B., F.R.S.; Machinery for book and general printing, by Mr. William Powrie; Evaporative Condensers, by Mr. Harry G. V. Oldham.

THE following particulars, referring to the experiments made by the Wireless Telegraph Company between the South Foreland lighthouse and the East Goodwin lightship, are given in the *Electrician*:—Permission was granted by the Trinity House authorities for the Company to make use of either the East-Goodwin, the Gull-stream, or the South Sand-Head light-vessel—the land station to be at the South Foreland lighthouse—and they chose the furthest off of these light-vessels, namely, the East Goodwin lightship, which is twelve miles distant from the South Foreland lighthouse. All the apparatus was brought on the lightship in an open boat and rigged up in the course of an afternoon, and on Christmas Eve the lightship and lighthouse were placed in perfect telegraphic communication. Many messages passed on that day, and there has not been the slightest hitch from the starting of the installation to now, every message sent from either shore or ship being perfectly received at the corresponding station. Although the weather has been most tempestuous since the instruments were installed, they have not been in the slightest degree affected.

TWO papers upon the subject of steel rails were read at the meeting of the Institution of Civil Engineers on January 17. Mr. W. G. Kirkaldy recounted how experiments he had carried out on two steel rails, which had broken under traffic, had led to his devoting special attention to the subject and to a wider investigation. It was found that the breakage of rails resulted from failure commencing at the top surface, and not from the bottom, as appeared to be the usual belief, and that the deterioration was confined entirely to the top or running head. The deterioration was of the nature of a mechanical hardening of the surface under the action of the rolling load. In some cases this hardening further developed into a species of disintegration by the formation of minute transverse cracks, which, by gradual deepening, ultimately resulted in failure, unless the rail was removed in time.

PROF. W. C. ROBERTS-AUSTEN, K.C.B., F.R.S., at the meeting referred to above, gave a statement of the principles which guide microphotography of steel rails. The most generally useful information as to the structure of a steel rail is obtained by treating a highly polished surface of the section with an effusion of liquorice in water, which stains the pearlite a dark tint, and leaves the ferrite unacted upon. The most convenient magnification is between 100 and 150 diameters. Normal rails have thus been shown to consist of patches of pearlite set in ferrite; and although the structure is common to all rails, the ratios of the areas differ widely, the amount of carbon increasing with the area of the pearlite. If the ferrite is arranged in large, enclosed polyhedrons, the temperature to which the rail was raised before rolling was too high. The strength and intensibility increase as the size of the grain diminishes; and closely interlocking ferrite and pearlite represent the condition which most favours the prolongation of the life of the rail.

IN connection with the works now being carried out for the construction of the new Vauxhall Bridge, the contractors have erected a suspension cable way across the Thames, for the purpose of conveying material from the shore to the different parts of the works. The length between the supports, each of which is 80 feet above the ground, is 910 feet; and the main cable, which is made of steel, is 6½ inches in circumference. The cost of this cableway is about 2000*l*.

A CIRCULAR, appealing for additional telegonic work, has been sent to biologists, and others whose interest in the subject is known, by Messrs. Alex. Meek and G. P. Bulman. In the course of the note it is remarked: "After a careful study of the facts already ascertained regarding telegony—that peculiar phenomenon of cross-breeding, popularly termed "throw-back"—we see that these can be attributed to reversion with almost as much likelihood as to telegony." It is, however, believed that telegonic effects are sometimes shown by the offspring; but more experiments are needed, and the circular indicates the kind of information required. Messrs. Meek and Bulman are conducting as many experiments as they can; but telegony is without doubt of extreme rarity, and the more trials that are made, the greater is the chance of success. Those who will assist are invited to send the skins of the parents and young which display telegony; also, in the case of birds, to send an egg out of each batch. All communications should be addressed to Mr. G. P. Bulman, Durham College of Science, Newcastle-upon-Tyne.

MESSRS. MAYER AND MÜLLER, of Berlin, are publishing in three volumes the mathematical correspondence of Gottfried Wilhelm Leibnitz, under the editorship of C. J. Gerhardt.

A CORRESPONDENT, writing in the *Journal of Applied Microscopy*, suggests that a convenient "pointer" for class demonstrations with the microscope may be made by cementing a human hair to the diaphragm of the eye-piece, projecting into the centre of the field. A better plan would be to cement the hair to a circular ring of blackened paper or cardboard, which could be placed on the diaphragm or removed at will.

A NEW bi-monthly journal has been started in Paris, bearing the title *L'Enseignement Mathématique*. It is to be devoted to discussion of methods of teaching mathematics, with the object of forming a medium of intercommunication between professors and others engaged in this particular branch of teaching. The first number bears the date January 15, 1899. The editors are Dr. C. A. Laisant (Paris) and Prof. H. Fehr (Geneva), and the publishers are MM. Georges Carré and C. Naud, 3 Rue Racine, Paris.

IN the *Nuovo Cimento*, 4, viii., Drs. V. Boccara and A. Gandolfi describe experiments on the velocity of propagation of Hertzian waves, undertaken for the purpose of verifying the well-known relation $v = 1/\sqrt{(k\mu)}$. The media operated on consisted of mixtures, in various proportions, of paraffin and finely pulverised iron. Both the magnetic permeability and the specific inductive capacity could be increased by increasing the proportion of iron, and the index of refraction for electromagnetic waves was found to increase correspondingly, its value (n) being given approximately by the relation $n = 1/\sqrt{(k\mu)}$. This relation may, therefore, be regarded as verified experimentally.

A NEW departure in connection with projection microscopes has been constructed for Prof. M. C. White, of Yale University, in the form of an objective of 20 mm. focal length, and an estimated numerical aperture of 0·95. According to the *Journal of Applied Microscopy*, the new objective is a magnified copy of a 5 mm. apochromatic, the diameters and radii of curvature of all the lenses being increased fourfold. Dr. White's theory is that if, in using the ordinary microscope, a certain angular aperture is required to secure proper definition with a magnifying power of, say, 1000 diameters, then a similar aperture will be necessary to secure good definition in an image projected on the screen, even if it is obtained with a three-fourths-inch objective, and a projection eyepiece. The new lens has been manufactured by the Bausch and Lomb Optical Company.

IN experiments upon the discharge of negative electricity by light, the electric arc is usually employed as the source of ultra-violet rays, and a question arises as to how far such experiments are affected by the electrical state of the vapours of the arc. The *Physical Review*, vol. vii. pp. 129–148, 1898, contains an article on this subject by Messrs. Merritt and Stewart. It was pointed out by Hallwachs, in 1890, that the protection offered by a quartz window and wire gauze is in some cases insufficient to screen the direct electrical action of the arc vapours from the actino-electric apparatus. The electrical properties of the arc vapours are similar to those of gases that have been acted upon by X-rays, or to gases from a flame. It is supposed in these cases that a condition is developed in the gas somewhat similar to that in an electrolyte, *i.e.* ions are formed, some carrying positive charges and others negative charges. This condition is only temporary; in the case of X-rays the gas loses this ionised state in about one-tenth of a second. A charged body placed in the ionised gas would attract one set of ions and repel the other. Upon coming into contact with the charged body the ions are supposed to give up their charges and to cease to exist as ions. The experiments of Messrs. Merritt and Stewart show that, except at low potentials, the rate of discharge is not proportional to the potential, but approaches a limiting value as the potential is raised. The discharging power is retained even after the arc vapours have been passed through long tubes of glass or of metal, and lasts for at least ten seconds. There is some evidence that the negative ions diffuse more rapidly than the positive ones. If air or oxygen saturated with water-vapour is introduced into the enclosure containing the arc, the conducting power of the arc vapours is greatly increased. But this effect can no longer be observed when the body to be discharged is at considerable distance from the arc.

FROM the Geological Survey of Canada we have received several essays reprinted from the Annual Report, vol. ix., 1898. A report on the geology of the French River Sheet, Ontario, by Dr. Robert Bell, is a concise explanation of one of the Geological Survey maps (Sheet 125), printed in clear type, accompanied by a colour-printed map on the scale of an inch to four miles, and issued at the price of ten cents! Laurentian, Huronian, Ordovician, and Silurian rocks are described, as well as Glacial and other superficial deposits. Among "economic minerals" it is observed that certain white quartzites would furnish excellent material for making glass.

MR. A. P. LOW reports on a traverse of the northern part of the Labrador peninsula from Richmond Gulf to Ungava Bay. Proceeding along the eastern shores of Hudson Bay, Mr. Low explored Richmond Gulf, which is separated from Hudson Bay by a high narrow ridge of Cambrian rocks, capped with trap, and forming cliffs which rise 500 to 1200 feet above the water. Between the Gulf and Clearwater Lake there is a plateau, having a general elevation of 750 feet, formed of rounded granitic hills, with numerous intervening lakes. North of Clearwater Lake is Seal Lake, which derives its name from the seals living in its waters. Mr. Low thinks that the presence of these animals in the lake, which is nearly a hundred miles from salt-water, and at an elevation of nearly 800 feet above the sea, can hardly be due to migration, although the harbour seal is known to travel overland for considerable distances. He considers that the seal must have reached the lake during the subsidence of the land at the close of the Glacial period. It evidently breeds freely under the fresh-water conditions. Explorations were made by Mr. Low as far as Fort Chimo, the most northerly post of the Hudson's Bay Company in Labrador. The rocks met with along the greater part of the route have been classed as Laurentian; they consist chiefly of foliated granite. Other eruptive rocks, also cherty dolomite and shales, grouped as Cambrian, were met with. The observations of striæ and other Glacial phenomena showed that the region had been completely covered with ice during the Glacial period, and that the ice moved outwards and downwards from a narrow névé near the present watershed. Old marine terraces were also noted.

JUDGING from the twelfth annual report of the Liverpool Marine Biology Committee, the biological station at Port Erin, Isle of Man, was used by a number of naturalists last year, and several investigations of interest and importance have been made with material collected from the neighbouring coasts. An interesting illustration in the report is a reproduction of a photograph, taken in June 1897, of a marked area of rock covered with adhering animals. By the side is another picture of the same area photographed after a year's interval, and it shows that the original population had disappeared almost entirely. All the original limpets had gone, leaving their scars on the rock; but a few barnacles seem to have remained. Many thousands of new animals appear on the second picture.

THE second instalment of the "Additional Series" of the *Kew Bulletin* forms the first of a series of "Selected Papers," and is devoted entirely to vegetable fibres. It comprises eighty-nine papers, amounting to 280 pages, already published in the *Bulletin*, and forms a valuable work of reference for all interested in the subject, whether scientifically or commercially.

RETURNING to the subject of the injury inflicted on agriculture in New South Wales by the introduction of the prickly pear, Mr. Maiden, the Government botanist for the Colony, now publishes (*Miscellaneous Publication*, No. 253, Department of Agriculture) a description of the six species of *Opuntia* at present naturalised in the colony, each illustrated by a good full-sized plate.

THE first number of Cohn's *Beiträge zur Biologie der Pflanzen* published under the editorship of Prof. Brefeld, consists of three papers: on the witch-broom of the barberry, by Dr. J. Eriksson; on the development of the Helvellineæ, by Herr G. Dittrich; and on inulin, by Dr. H. Fischer. Dr. Fischer believes inulin to be a substance of much wider distribution in the vegetable kingdom than has generally been supposed. It is never a final, but always an intermediate, product in the process of assimilation. It may be formed by condensation out of fructose, which, after transport to the reserve receptacles, is again transformed into inulin, then into glucose, and finally into starch.

WE have received a reprint of a lecture on the South Wales Coal-field, by Mr. W. Galloway, being Subject I. of a course of lectures on mining, published by the South Wales Institute of Engineers. The lecture is illustrated by a capital colour-printed geological map showing the areas occupied by the steam-coal and anthracite collieries. The structure of the coal-field is well explained, and there is a general account of the mode of formation of coal, and of the organic remains of the Carboniferous period.

PROF. ARTHUR THOMSON will contribute a series of papers to *Knowledge*, dealing with the treatment and uses of anthropological data. The first article is to appear in the February number.

IN aid of the funds of the Distressed Gentlefolk's Aid Association, Mr. C. Carus-Wilson will lecture upon "The Marvels of Ice and Glaciers," at the Kensington Town Hall, on Wednesday, February 1, at 8.30 p.m.

"THE Resources of the Sea; or, an Inquiry into the Experiments on Trawling and the Closure of Areas," is the title of a work, by Prof. McIntosh, to be issued shortly by the Cambridge University Press. The work is accompanied by thirty-two tables, and various photographs and figures.

A COPY of an important paper on cell structure and nuclear division, entitled "Über Zellen- und Syncytienbildung. Studien am Salmonidenkeim," by Prof. Wilhelm His, has been received. The paper is an excerpt from the *Abhandlungen der mathematisch-physischen Classe der Königl Sächsischen Gesellschaft der Wissenschaften* (vol. xxiv. No. 5), and is illustrated by forty-one figures in the text.

TWO volumes (vols. i. and v.) of the "Traité de Zoologie Concrète," by Prof. Yves Delage and M. Hérouard, have already been noticed in these columns (vol. lviii. p. 25, May 1898). Another volume (vol. viii. pp. 379), dealing with the Chordata, and containing 54 plates and 275 figures in the text, has just been published. There will be nine volumes in all, only three of which have yet been published.

UNDER the title "The Last Link; our Present Knowledge of the Descent of Man," the paper read by Prof. Ernst Haeckel at the International Congress of Zoologists last August (see vol. lviii. p. 427), has been published by Messrs. A. and C. Black, with notes and biographical sketches by Dr. Hans Gadow, F.R.S. Prof. Haeckel states his case in eighty pages, and Dr. Gadow's biographical sketches, and instructive notes on the theory of cells, factors of evolution, and geological time occupy seventy-six pages.

THE Wagner Free Institute of Science, Philadelphia, has published the fourth part of Prof. W. H. Dall's memoir on the "Tertiary Fauna of Florida," with special reference to the silex beds of Tampa, and the Pliocene beds of the Caloosahatchie river, and including in many cases a complete revision of the generic groups described, and their American Tertiary species. The present part of the work includes the Priomodesmacea and Teleodesmacea. Prof. Dall expresses the hope that another part will conclude this series of papers, and comprise, besides the remaining descriptions, a summary of the faunal population of each of the principal Neocene horizons.

THE Vatican Observatory has recently issued volume v. of *Pubblicazioni* (xxiii. + 808 pages). The work is divided into four sections—astronomy (including observations of shooting stars), terrestrial magnetism, earthquake phenomena, and meteorology. The meteorological observations for the years 1893 and 1894, and ten-day and monthly means, are tabulated under each hour, in addition to the usual daily means and extremes. The whole work is beautifully executed, and contains some good astronomical and other plates. About 220 pages are devoted to a summary of the proceedings at the weekly meetings held at the observatory during the years 1894 and 1895.

The annual report of the Smithsonian Institution for the year ending June 1896 has been received. It is well known that the value of Smithsonian Reports lies not so much in the account of the operations and conditions of the Smithsonian Institution as in the collection of papers on various scientific subjects, included in the appendix. The report of the Secretary on the work of the Institution is published many months in advance of the volume containing it and the appendix referred to. In the present volume this report, and general administrative affairs, occupy only 77 pages, while the appendix, containing a selection of papers (some of them original), embracing a wide range of scientific investigation and discussion, occupies more than six hundred pages. These pages consist of addresses delivered at scientific meetings, and upon other occasions, reprints and translations of contributions to scientific periodicals, and reports on some investigations carried on under the auspices of the Smithsonian Institution. There are thirty memoirs of this kind in the present report, and together they form a most interesting statement of work and progress in many branches of science.

The additions to the Zoological Society's Gardens during the past week include two Arabian Baboons (*Cynocephalus hamadryas*, ♂ ♀) from Arabia, presented by Dr. H. O. Forbes and Mr. W. R. Ogilvie-Grant; a Rhesus Monkey (*Macacus rhesus*, ♀), a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. P. de Loriol; a Patas Monkey (*Cercopithecus patas*, ♂) from West Africa, presented by Mr. C. H. Wimpress; a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Mr. Fraser; a Nankeen Night Heron (*Nycticorax caledonicus*) from Australia, presented by Mr. John Brinsmead; two Diamond Pythons (*Python spilotes*) from Australia, presented by Mr. S. A. Michels; a Grey Lemur (*Hapalemur griseus*) from Madagascar, an Argali Sheep (*Ovis ammon*, ♂) from the Altai Mountains, deposited; four Ruddy-headed Geese (*Chloephaga rubidiceps*), bred in Holland, purchased.

OUR ASTRONOMICAL COLUMN.

Comet Chase.—The following ephemeris for Comet Chase will be found serviceable by those who wish to observe this object. It has been calculated by Herr J. Möller, and is as follows:—

Berlin Midnight.

1899.		R.A. (app.). h. m. s.		Dec. (app.). ° ′
Jan. 27	...	11 9 35	...	+33 35·9
29	...	9 16	...	33 57·9
31	...	8 52	...	34 19·5
Feb. 2	...	8 23	...	34 40·5
4	...	11 7 48	...	+35 1·0

The brightness of the comet is about the same as at the time of discovery.

New Variable Star in Andromeda.—Dr. T. D. Anderson announces (*Astr. Nachr.*, No. 3539) a new variable star in Andromeda, the approximate position of which for 1855 is

R.A. 2h. 8m. 23s. ... Dec. +43° 37′·8

Using for comparison stars BD + 43°·457, 460 and 462, and estimating their respective magnitudes as 9·2, 8·8 and 9·7, he found the following values for the magnitude of this variable:—

1898 Dec. 3	...	...	Mag. 9·1
6	...	...	9·1
28	...	...	9·5
1899 Jan. 3	...	...	9·6
7	...	...	9·7

The star has thus rapidly decreased six-tenths of a magnitude in this short period, and it will be interesting to follow the variation further.

Witt's Planet (433) DQ.—The recent *Harvard College Observatory Circular* (No. 36) gives an account, with the results, of a search for the planet Witt among some negatives of star regions taken at that observatory. With the help of Mr. Chandler, who furnished an ephemeris based on the best material, Mrs. Fleming undertook the examination of the plates for the year 1894; but in the first instance, although the latter examined a region covering 1300 square degrees, the planet was not found. The next search was made upon the plates taken in 1896, as the errors of the ephemeris would not then be so great, and might possibly compensate for the extreme faintness of the planet. The result of this search was that at last a faint image was found on a plate taken on June 5, 1896, and this was confirmed on plates exposed on June 5 and 6.

From these positions the ephemeris was corrected, and positions for 1894 computed. A further examination by Mrs. Fleming brought to light impressions of the planet on several other plates taken in 1894 and 1893. In addition to the positions of the planet at the times each of these photographs was obtained, Prof. Pickering publishes in the present *Circular* an ephemeris from 1893 October 27 to 1894 April 21, computed by Mr. Chandler from a combination of the observations of 1898, and the photographs taken on December 19 and 27, 1893; February 16, 1894; April 6, 1896; and June 4 and 5, 1896.

The elements calculated by Mr. Chandler from such a combination of positions are the following:—

Elements.

Epoch 1898, August 31·5 G.M.T.

$$
\begin{aligned}
M &= 221^\circ\ 35'\ 45''\cdot6 \\
\omega &= 177\ \ 37\ \ 56\cdot0 \\
\Omega &= 303\ \ 31\ \ 57\cdot1 \\
i &= 10\ \ 50\ \ 11\cdot8
\end{aligned}
\Bigg\}\ 1898\cdot0
$$

$$
\begin{aligned}
\phi &= 12\ \ 52\ \ 9\cdot8 \\
\mu &= 2015''\cdot2326 \\
\log a &= 0\cdot1637876 \\
\text{Period} &= 643\cdot10\text{d.}
\end{aligned}
$$

It may be mentioned that further images of the planet have been found on plates taken in November 26, December 23, 1893, and in January 19, 25, 30, and February 5 of the following year.

On a previous occasion in this column (December 1, 1898, p. 108) we drew attention to a suggestion by Prof. Chandler, who gave his reasons why Pluto would be an appropriate name for this new planet. In the *Astronomische Nachrichten* (No. 3539), Dr. G. Witt, the discoverer of the planet, proposes to call it by the name Eros, hoping that this will be found suitable for such an important little body.

The Hamburg Observatory.—Prof. F. Küstner, the director of the observatory at Bonn, has been appointed to take over the directorship of the Hamburg Observatory, in succession to Prof. G. Rümker, who has, we are sorry to say, retired owing to prolonged illness.

The Leonids in 1898.—Several additional accounts of the observations of the Leonids at different stations are published in the *Astronomische Nachrichten* (No. 3538). Those made at Vienna and Pola seem of special interest. In Vienna the three nights of the 13th, 14th and 15th were useless for observation; but Dr. Palisa, with Herr J. Rheden, ascended the "Semmering," and were fortunate in having clear weather after midnight on the night of the 13th. Between 3h. and 5h. 30m. twenty-two meteors were seen, thirteen of which were Leonids, but all below the second magnitude. On the evening of the 14th, Prof. E. Weiss also ascended to this point, taking with him two photographic cameras. Between 3h. 15m. and 5h. 45m. about 250 meteors were seen, two-thirds of which were estimated as Leonids, and several brighter than Venus. On the photographic plates six trails were recorded, one of which belonged to an interesting meteor which was observed to be as bright as Jupiter, and came from the radiant R.A. 153° + 23°. On the night of the 15th, Dr. Palisa and Herr Rheden, observing from the same station between 10h. 45m. p.m. and 2h. 30m. a.m., saw fifty meteors, many of which were very bright, but only about twenty-five of them Leonids. These observations indicate that the forerunners of the swarm reached the earth in the night of the 13th–14th, the maximum being reached probably during the day of the 15th. Prof. Weiss adds that the passage through these meteors lasted for more than twenty-four hours, suggesting that the width of the swarm had increased very considerably since 1866.

In Pola, on the night of the 15th, the meteors seem to have been well seen, eighty-three being observed, thirty-four of which were Leonids. The maximum of the display is stated to have taken place at 16h. 48m. Pola M.T., the radiant point deduced from twenty-two of the best observations being R.A. 10h. 12m. + 26°·5.

STUDIES OF THE LUNAR PHOTOGRAPHS TAKEN WITH THE LARGE EQUATORIAL COUDÉ.[1]

THE new part of the "Atlas of the Moon," which we offer to the public to-day, presents many points of comparison with sections previously published. But, on account of changes of the moon's age and her libration, the portions common to both serve no double purpose. The comparison of the negatives, as we shall see more especially by studying Plates XV. and XVI., enables us to interpret some dark markings, to establish a finer distinction between the unevenness of the surface and the variations from the ordinary colour, and finally to determine more precisely the points where the reality of a periodic change may be presumed.

Plate *c* is the third in our publication, in which the whole of the moon, visible simultaneously from the earth and sun, is represented. This portion is here much more restricted than has already appeared in Plates *a* and *b*. The new sheet is, in consequence, less rich in detail, but derives a particularly expressive appearance, due to the rapid change from shadow to light. It is naturally the general features of the physiognomy of our satellite, the laws of distribution of plains and mountains, which can be usefully studied on these unenlarged pictures. We call special attention to the polygon form of the *Mer des Crises*, which is the best defined of all the dark plains of the moon; to the traces of progressive depressions which are presented in its central portions; to the large rectilinear valleys which are visible in the southern part of the disc; to the alignment following a meridian of the four most important circles of the southern horn; to the existence of a long series of dark spots on another meridian near the limb. We find altogether, in this part of the moon, a well-marked relation between the local appearance of the surface and longitude. This relation is interesting to note, owing to the probability of its being connected with the mechanical work of tides caused by the earth.

The three unenlarged proofs published as yet demonstrate several important facts, which are confirmed by a number of clichés in our possession. They are:—

(1) A nearly continuous progression of light, extending from the terminator to the illuminated limb, approximately coincident with the curves of equal illumination and the meridians.

(2) A recrudescence of illumination in the neighbourhood of the poles, and principally of the South Pole.

(3) A marked increased of luminous intensity in the immediate neighbourhood of the limb.

A satisfactory theoretical explanation is possible for the first law, if the moon be regarded as a uniform globe in its superficial constitution, without appreciable atmosphere, beyond the state of exercising a sensible specular reflection, and reflecting indifferently in every direction the light received. Under these conditions the formula which expresses the relative intensity, and which will be found in the note relating to Plate *c*, indicates that the curves of equal illumination are the meridians, and that the intensity must increase from the terminator to the limb.

The slight exception to this rule, which is apparent near the poles, already attracted our attention when we described Plates I., II. and VI. We there saw the proof that these portions of crust very soon became solidified and rapidly acquired a great thickness. By this the polar caps have escaped the inundations originating from the interior, which have changed the appearance of the equatorial region. They are found to receive more rapidly the deposits of white cinders of the volcanic period, chief cause of the difference of tints which we observe to-day.

One may attempt to go further back, and to account for the early solidification of the polar regions. It is evident, to begin with, that the cooling must progress more quickly under the influence of a less efficient solar radiation. We will add that the tides of terrestrial origin caused smaller oscillations than in the equatorial regions, and having a slower velocity of propagation. The congealing of the superficial scoriæ is, therefore, much more easily effected near the poles.

The third fact, that is to say the abnormal increase of luminosity near the limb, merits more attention, because it is not the result of the mode of operation adopted, which, on the contrary, would be of a nature to weaken it. It shows itself in every latitude, and in all phases. In particular, the photographs taken during the partial eclipse of January 7, 1898, show that the increase of intensity on the edge is still very appreciable at opposition—that is to say, at the moment when calculation would assign a uniform brilliancy to the lunar disc.

It seems that no purely geometrical theory accounts for this appearance if it is not supposed that it is really connected with the physical state of the surface—that is to say, that not only the polar caps, but all the regions which form the apparent "contour" of the moon are, collectively, of a lighter colour than the other parts of the disc.

Here, again, the tides of terrestrial origin, already studied from other points of view by MM. Faye and Poincaré, appear to have played an essential part. Their character is entirely modified, since the day when the rotation of the moon upon its axis was equal to the period of revolution. The periodical flow, which formerly invaded the whole equatorial region, finished by accumulating in the portion of the disc which the earth sees at the present day near its zenith. Besides this our globe, still incandescent, was really a source of great heat for its satellite. The regions near the limb have therefore entered, in their turn, into this period of low temperature and relative calm which is favourable to the consolidation of the polar regions.

The real characters of the high latitudes, already notified in the previous part, can be more completely studied here on Plates XIII. and XVII. The latter shows us the South Pole covered with mountains, varying in height from 6000 to 7000 metres, the highest that have been measured on the moon. These depths are not entirely due to the hollow of the walled plains. Although very numerous, sufficient space is left between them to allow us to judge of what was the previous contour. It can be seen that it comprised very high ridges which the craters have encroached on without destroying, and without themselves losing the regularity of their contour. There have thus been formed between the different parts of the same enclosure, differences of level which mount up to 1500 or 2000 metres. The most elevated points, which seem to correspond to a very thick crust, and capable of offering great resistance are, on the contrary, often full of little craters. The general appearance of the region gives rise to the thought, as we have already said of Plate VI., that there does not exist a covering of ice at the poles, and that it has not produced an active erosion there.

If we now consider Plate XIII. in the neighbourhood of the North Pole, we see the walled plains occupying a still more secondary place. Here the seas advance to very high latitudes. Long mountainous masses exist between them, as, for instance, the Alps and the Caucasus. These ranges, situated at a higher level than that of the seas, are strewn with summits presenting well-marked alignments, but no sign of ramified valleys, and very little circular formation. They are broken up into several fragments by rectilinear fissures, of which the great valley of the Alps constitutes the most celebrated and best example. The portions thus separated seem to have undergone sliding movements in relation to one another. Considerable difference of level is manifested in one *massif*, in such a manner that it ends at one side by a very high and very steep descent, while the other descends insensibly to the seas. The signs of primitive level have no other common feature with the terrestrial mountains than their great relative altitude, and prolonged atmospheric agencies would be necessary to make them acquire new features of resemblance with them. If the North Pole is approached, it will be seen that at the surface a net-work of furrows are formed in such a manner as to produce rectangular basins. The higher the latitude, the more important these movements of the ground become; and it is credible that, if we could see past the apparent contour of the moon, we would observe a relief comparable with that of the South Pole. The undeniable difference which to-day exists between the appearance of the two poles is favourable to the views of G. H. Darwin and other geometers, who estimate, for reasons derived from celestial mechanics, that

[1] Translation of a paper by MM. Lœwy and Puiseux. (Published by the Paris Observatory.)

the inclination of the axis of rotation of the moon to the plane of the orbit has undergone important variations.

In order to understand the mechanism of the depressions which have caused the seas, the phenomena must be seen at different stages of advancement, and for this purpose it is necessary to study in detail how the transition between the great southern cap, which is mountainous, and the plains of the equatorial region have been effected. This passage may be studied on Plate XIV., of which nearly half, occupied by the *Mer des Nuages*, indicates numerous obliterated or submerged formations. The traces of the most ancient depressions have naturally disappeared by the overflowing of lava, but the more modern depressions on a dry and resisting crust, often allow their contour and size to be recognised. Some of these are connected to the central portions of the seas, leaving a great exterior band joining the mountains, which serve at the same time as limit and fulcrum. The two portions of crust thus disjointed have only been able to acquire a relative movement in a vertical direction. The part which remained immovable constitutes, in relation to the other, a sort of raised terrace. Thus must be interpreted the celebrated formation known by the name of "The Straight Wall." As the same map shows it us a little distance off, the rupture can also be accompanied by a tangential slip. It appears then like a large crevice, similar to those we saw appearing to the east of Hesiod. These fissures may be connected with large portions of the crust, may even divide chains of hills, and their form, generally rectilinear, seems independent of all the small inequalities of the surface.

It can easily be understood that such crevices rarely acquire dimensions large enough to be visible from our earth. Further, it is only near the boundaries of the seas that they have a chance of remaining open. In the central parts, the submersion of the surface has made every vestige disappear. The zones near the limb are also, by reason of the variations of the interior pressure, subject to encroachments of lava. But these inundations, which are not so frequent, are not uniformly distributed. They give rise to solid accumulations along the crevices from which they issue, and they take the form of swollen nerves. Two of these net-works can be studied in the present—and third—part; one stretching to the west of Bouillaud (Plate XIV.), the other between Landsberg and Wichmann (Plate XV.). In this last system we see a large region composed alternately of hollows and hills, as if to enable us to note the change.

The evidence of volcanic action appears here with an amplitude, a clearness, which leaves little to be desired. We have had to content ourselves with a somewhat smaller enlargement in order to comprise in two consecutive pages (Plates XV. and XVI.) the largest portions of these brilliant aureoles, that are seen shining round certain walled plains, as Lalande, Kepler, or Copernicus. It seems to us that the comparison of these two pages is very suggestive. One is convinced by it that the diverging trails, becoming invisible by a very oblique illumination, cannot be interpreted as inequalities of the surface. Intersecting valleys and mountains without becoming fainter or deviating from their course, they cannot have been produced by subterranean or superficial means. An atmosphere agitated by variable currents seems to be the only cause which can explain the diffusion of tracks to such distances. This hypothesis further agrees with what we know of the extreme tenuity of volcanic dusts, with their capability of remaining for a long time in suspension in very thin air. It is strengthened by the fact of the existence of a relatively dark corona round the principal centres of luminosity. It is possible that in a certain zone round the more recent craters, like the region in the neighbourhood of terrestrial volcanoes, the largest projectiles, the streams of lava have got mixed in the deposits of cinders, and have not allowed them to remain clearly visible near these orifices.

Without misunderstanding the evident unity of origin of these tracks of a same system, one might be surprised to see their direction, their size, and their brightness sometimes undergoing sudden changes without clear relation to the distance of the central crater. Two disturbing causes seem to interfere: one is the meeting of high mountains, capable of dividing the atmospheric currents, of causing downfalls, and abundant condensation. The other, more frequent and more efficient, is the presence of hollow basins, still liquid at the time the downfalls of cinders took place, useless in consequence of receiving or keeping superficial deposits. The tracks, therefore, behave in the plains like a very sensitive reagent, being able to disclose by a recrudescence of brightness the smallest unevenness of the surface, and, by a sudden weakening, the slowly solidified lagoons. The comparative examination of a similar region, described in the Plates XV. and XVI. under contrary conditions, furnished numerous facts in support of this idea.

Are some of these deep basins still imperfectly dry, and will their physical state consequently be changed by a prolonged exposure to the solar rays? The green and red tints that are seen in the neighbourhood of the terminator, in the interior of some walled plains, make one think that this is so. The eye being more sensitive in the appreciation of tints, photography has the advantage of the impartial registering of relative luminous intensities. It has, without contradiction, the right to bring its evidence into the question. Plate XVII., which represents a region where the sun is setting, must be compared from this point of view with Plate I., where the sun is rising on the same parts. We find these dark spots of even tone, which in the interval have obviously modified their tints relatively to the neighbouring plateaus. The reality of this change has been confirmed by the examination of a series of clichés arranged in intermediate phases.

Below we sum up the principal ideas which this third part suggests or confirms, and which one will find developed in the following pages containing the description of the different plates. They are :—

(1) The explanation of the relative stability and the mountainous character of the polar caps.

(2) The extension of these same characters to every region which form the apparent limb.

(3) The geometric reason of the approximate coincidence that one sees between the curves of equal illumination on the disc and meridians.

(4) The origin of the abnormal recrudescence of luminosity which is shown at the apparent limb in contradiction to calculation.

(5) The difference of constitution of the two poles seems to indicate that the axis of rotation has undergone great displacements in the interior of the planet.

(6) The cause of the predominance of the seas in equatorial regions.

(7) The interpretation of the different tints that are apparent in the tracks; the use of the dark spots to recognise, amongst the sunken basins of the lunar surface, those which have been the last to solidify.

Results of equal interest can apparently be deduced from the fourth and fifth parts, the materials of which we have in hand. We hope the studious public will not have very long to wait for the rest of this work, for it has indeed been good enough to see in the two first parts an appreciable addition to our selenographic knowledge. However, we do not doubt that it is possible to do more, and also better; for if we think we have brought the methods of reproduction to the desired degree of perfection, it is not the case in the execution of direct photographs, which remains, by reason of the habitual movement of the images, a very difficult operation. A single cliché, available for enlarging, represents practically for us the only result of several months' work, and in certain phases our best proofs betray, in a very apparent way, the unsteadiness of the atmosphere.

OYSTERS AND DISEASE.[1]

THIS research was commenced three years ago, and has been carried on intermittently in the intervals of other work.

Preliminary reports on some of our results have been laid before the British Association at the Ipswich, Liverpool, Toronto, and Bristol meetings, and a short paper on one section of the subject was communicated to the Royal Society and printed in the *Proceedings* last year. In the present paper we give a full account, with illustrations, of the detailed evidence upon which our various conclusions are based. The following is a brief statement of the more important results given in the paper :—

(1) Although our primary object was to study the oyster under unhealthy conditions, in order to elucidate its supposed connection with infective disease, we found it necessary to study

[1] "Observations upon the Normal and Pathological Histology and Bacteriology of the Oyster." By Profs. W. A. Herdman, F.R.S., and Rubert Boyce. (Abstract of a paper read before the Royal Society, January 19.)

in minute detail the histology of certain parts of the body, especially the gills and mantle lobes, the alimentary canal and liver. We give figures and descriptions of these structures in both normal and abnormal conditions.

(2) We have also worked out the distribution and probable function of a miuute muscle, which we believe to be the modified representative of the protractor pedis muscle of some other molluscs.

(3) A diseased condition we found in certain American oysters very soon brought us into contact with the vexed question of the "greening" of oysters, and one of the first results we arrived at was that there are *several distinct kinds* of greenness in oysters. Some of them, such as the green Marennes oysters, and those of some rivers on the Essex coast are healthy; while others, such as some Falmouth oysters, containing copper, and some American oysters re-bedded on our coast, and which have the pale-green "leucocytosis" described in our former paper to the Royal Society, are not in a healthy state.

(4) Some forms of greenness (*e.g.* the leucocytosis) are certainly associated with the presence of a greatly increased amount of copper in the oyster, while other forms of greenness (*e.g.* that of the Marennes oysters) have no connection with copper, but depend upon the presence of a special pigment, "marennin."

We are able, in the main, to support Ray Lankester in his observations on Marennes oysters; but we regard the wandering amœboid granular cells on the surface of the gills as leucocytes which have escaped from the blood spaces, and have probably assumed a phagocytic function.

(5) We see no reason to think that any iron which may be associated with any marennin in the gills, &c., is taken in through the surface epithelium of the gill and palps, but regard it, like the rest of the iron in the body, as a product of ordinary digestion and absorption in the alimentary canal and liver.

(6) We do not find that there is any excessive amount of iron in the green Marennes oyster compared with the colourless oyster, nor do the green parts (gills, palp, &c.) of the Marennes oyster contain either absolutely or relatively to the colourless parts (mantle, &c.) more iron than colourless oysters. We therefore conclude that there is no connection between the green colour of the "Huîtres de Marennes" and the iron they may contain.

(7) On the other hand, we do find by quantitative analysis that there is more copper in the green American oyster than in the colourless one; and more proportionately in the greener parts than in those that are less green. We therefore conclude that their green colour is due to copper. We also find a greater quantity of iron in those green American oysters than in the colourless; but this excess is, proportionately, considerably less than that of the copper.

(8) In the Falmouth oysters, containing an excessive amount of copper, we find that much of the copper is certainly mechanically attached to the surface of the body, and is in a form insoluble in water, probably as a basic carbonate. In addition to this, however, the Falmouth oyster may contain a much larger amount of copper in its tissues than does the normal colourless oyster. In these Falmouth oysters the cause of the green colour may be the same as in the green American oyster.

(9) By treating sections of diseased American oysters under the microscope with potassium ferrocyanide and various other reagents, we find that the copper reactions correspond in distribution with the green coloration; and we find, moreover, from these micro-chemical observations that the copper is situated in the blood-cells or leucocytes, which are greatly increased in number. This condition may be described as a green leucocytosis, in which copper in notable amount is stored up in the leucocytes.

(10) We find that an aqueous solution of pure hæmatoxylin is an extremely delicate test for copper, just as Macallum found it to be for iron.

(11) Experiments in feeding oysters with weak solutions of various copper and iron salts gave no definite results, certainly no clear evidence of any absorption of the metals accompanied by "greening."

(12) Although we did not find the *Bacillus typhosus* in any oysters obtained from the sea or from the markets, yet in our experimental oysters inoculated with typhoid we were able to recover the organism from the body of the oyster up to the tenth day. We show that the typhoid bacillus does not increase in the body or in the tissues of the oyster, and our figures indicate that the bacilli perish in the intestine.

(13) Our experiments showed that sea-water was inimical to the growth of the typhoid bacilli. Although their presence was demonstrated in one case on the twenty-first day after addition to the water, still there appeared to be no initial or subsequent multiplication of the bacilli.

(14) In our experiments in washing infected oysters in a stream of clean sea-water the results were definite and uniform; there was a great diminution or total disappearance of the typhoid bacilli in from one to seven days.

(15) The colon group of bacilli is frequently found in shellfish as sold in towns, and especially in the oyster; but we have no evidence that it occurs in mollusca living in pure sea-water. The natural inference that the presence of the colon bacillus invariably indicates sewage contamination must, however, not be considered established without further investigation.

(16) The colon group may be separated into two divisions: (1) those giving the typical reactions of the colon bacillus, and (2) those giving corresponding negative reactions, and so approaching the typhoid type; but in no case was an organism giving all the reactions of the *B. typhosus* isolated. It ought to be remembered, however, that our samples of oysters, although of various kinds and from different sources, were in no case, so far as we are aware, derived from a bed known to be contaminated or suspected of typhoid.

(17) We have shown also the frequent occurrence, in various shell-fish from the shops, of anaërobic spore-bearing bacilli giving the characteristics of the *B. enteritidis sporogenes* recently described by Klein.

(18) As the result of our work, we make certain re commendations as to the sanitary regulation and registration o the oyster beds, and as to quarantine for oysters imported from abroad.

THE DUKE OF DEVONSHIRE ON SECONDARY EDUCATION.

THE Duke of Devonshire opened the new building of the Municipal Technical College at Derby on Thursday last; and in the course of an address delivered at a luncheon given by the Mayor of Derby on that occasion, he is reported by the *Times* to have made the following remarks upon the value of scientific instruction and the reform of secondary education.

The inhabitants of Derby had not up to the present time enjoyed all the advantages in obtaining a scientific education which would have been so useful to a town possessing so many, so large, and so varied industries. But science instruction in Derby was now, he trusted, entering upon a new course, and he had little doubt that the instruction in science which would be carried on in that building would be as thorough as that which had hitherto been accomplished in the art school. Though they had made a great step in the erection and completion of these buildings, a great deal still remained to be done. The erection of the most complete buildings and the calling of them a college would not be of much use unless at the same time they were able to obtain a competent staff of teachers. That, he had no doubt, had already been done; but, even when they had done that, they must remember that independent classes and courses of lectures, useful as they might be in enabling students to acquire certain branches of knowledge which would be of use to them in future years, would not, unless they were organised on the principles to some extent which prevailed in our older schools and colleges, provide that intellectual training and that mental discipline which was more valuable than any acquired knowledge.

He and many with him, much more able than himself, had during a good many years advocated the absolute national necessity of giving to our people a better technical, artistic, and scientific training. He had urged it in the interests of the maintenance of our industrial supremacy and in the interests of our industrial and commercial existence. The necessity for placing these means of technical instruction within the reach of our people was now universally admitted. There was a movement in this direction in every part of the country, and, in addition to what had hitherto been known as the technical education movement, there was an equally strong desire for the addition of what was termed commercial education. But what he thought was not yet quite clearly understood, and what he felt he had hitherto failed to understand himself more than in a very imperfect degree, was that we could not have technical, scientific, or artistic training to any great extent or in any valuable degree except as part of a sound general system of secondary education. We could not graft scientific or artistic education upon the stunted stem of deficient elementary education. On the other hand, he believed that the special study and development of a sound general system of education would be found to be of great and daily-increasing advantage. For this reason he had seen with great satisfaction that a good deal of attention had been paid during the last few weeks to a measure which he had laid before Parliament last year for the purpose of obtaining discussion and criticism, and which he hoped, either in its former or in an altered shape, to introduce again very shortly into Parliament with a view to its passage. The object of that measure was to commence—it did not profess to do more—the reform and reorganisation of our secondary education.

If the provisions of the Bill were of a limited character, and were confined to the creation of a central educational authority, it was because the Government were of opinion that it was best and wisest to proceed by degrees and with precaution, and to put their own house in order before they attempted to arrange the houses of other people. They admitted that a great deal of the confusion and want of co-operation which existed locally found its counterpart in the central departments in the metropolis between the Charity Commissioners, the Endowed Schools Commissioners, the Education Department, and the Science and Art Department. There had not hitherto been that unity of action and that thorough common understanding of objects and aims which would enable those Departments to give sound and practical advice to the local authorities. The Government believed that if they succeeded—and they hoped to succeed—in uniting these educational authorities at the centre into one harmonious and powerful organisation, then, without attempting to impose upon the country any cast-iron system, while leaving to localities perfect freedom to adapt their own educational methods to their own ends, they would be able to afford them through their experts and their inspectors that assistance and guidance which would enable them to carry out efficiently their important duties.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Vice-Chancellor publishes a further list of donations to the Benefaction Fund, established last year, which brings the total up to 8557*l.* The list includes a donation of 1000*l.* from Lord Iveagh. Prof. Ewing has also received a promise from an anonymous donor of 500*l.* to be expended on apparatus for the Engineering Laboratory.

The Agricultural Science Syndicate reports that twenty-one candidates have now received the University diploma in Agriculture. Of these fourteen have studied in Cambridge: seven are now engaged in teaching, and seven in farming or land agency.

CLIFTON COLLEGE has achieved remarkable success in the recent examination for admission to Woolwich and Sandhurst, the first place in each list having been gained by a Clifton boy direct from school. This is the first examination held under the new syllabus, which was so severely criticised in the papers about two years ago. Though materially reduced, the scheme still remains the most exacting that has yet been proposed to army candidates.

THOSE who are working in the cause of higher education among the Mahomedans have (says the *Allahabad Pioneer Mail*) been much encouraged by a letter that Mr. Justice Budruddin Tyabjee, of Bombay, has addressed to the Nawab Mohsin-ul-Mulk, in reference to the scheme for raising the College at Aligarh to the status of a Mahomedan University. The learned judge, who so worthily represents Mahomedan culture and enlightenment in his own Presidency, has expressed warm approval of the idea, and has supported his approval with an offer of a subscription of 2000 rupees towards the endowment fund.

PROF. W. A. HERDMAN, F.R.S., remarks in the twelfth annual report of the Liverpool Marine Biology Committee that there are two practices in American universities which excite the envy of professors in this country. One is the "sabbatical year"—the one year in every seven given for purposes of travel, study, and investigation. The other is the frequent endowment of an expedition—or equipment of an exploring party—by an individual man or woman who is interested in the subject, and can give a special fund for such a purpose. The Columbia University in New York, the Johns Hopkins University in Baltimore, Yale College in Newhaven, and Harvard at Cambridge, have all benefited immensely in the past by such exploring expeditions. Nearly every year of late has seen one or more of such, due to private generosity, in the field; and the work they have done has both added to general scientific knowledge, and has also enriched with collections the laboratories and museums of the college to which the expedition belonged.

THE absurd mistakes made by school children in writing answers to examination questions are often due to imperfect teaching, and they point to the need of more rational methods of instruction. The *University Correspondent* publishes a classified collection of these mistakes annually, and from the list that has just appeared we select a few, not in a spirit of levity, but to warn teachers who instruct children in the principles of science to be sure that their pupils comprehend their lessons. In geography the following answers occur:—The North Pole is a stick put in the ground by the explorer who can go farthest north.—A delta is a burning mountain.—If you stand on the seashore on a clear day, you can watch a vessel sailing round the world. This is a proof that the world is round.—The Sunderbunds are the hot winds which blow across the desert of Sarah.—Cañons are pieces of rope the Americans catch wild horses with.—A moraine is a disease which afflicts cattle in hot countries. The following answers, classified under mathematics and science, are amusing:—A trapezium is the thing in a gymnasium.—Elements are those metals which do not combine with other things, such as earth, alumium, water, fire, air, &c.—Latent heat is little particles of steam joined together so as you can't see them.—The solar spectrum is a group of stars so called in consequence of its being nearer the sun than any other group.—The stomach is the most diluted part of the elementary canal.—Wind is that which the dust blows along the street.

MR. JAMES STUART, M.P., delivered an address at St. Andrews University on Monday, the occasion being his installation as Rector of the University. In the course of his remarks he pointed out that much of the trade and commerce of the country was now under conditions in which the knowledge it was based on could be with advantage submitted to ordinary scientific treatment. But trade and commerce were still outside the pale of their University system, and those who followed them had to content themselves with the crumbs which fell from other tables. From the Universities' own point of view it daily became more necessary to provide new outlets for their students. There was undoubtedly an increased and increasing demand by those who wanted to learn that they should be taught subjects which bore upon their every-day life—sanitary science, physiology, anatomy, geology, chemistry of the arts, electricity, political economy, the history of trade and of their colonies, and modern languages. Many wanted those things who did not care for Latin or Greek or pure mathematics, and it would not do for the Universities to sit down and say, "We will not teach you these things because they are not academic subjects." They should not fear the curriculum being too full; students could always select for themselves what they wanted to study, and they ought to strive to give men wide chances of knowing what the state of knowledge was. There was more spent on trade and manufacture in some single towns in Germany now than in all broad Scotland put together. Their education in trade and manufacture was miserably behind, and yet this was at a moment when everything in the national race depended on such education. No one who had compared the advance of Germany in education with their own stagnation, even during the last quarter of a century, could fail to tremble at the insecurity in which this nation stood. It was his opinion, as one who had watched this for long, that it was not too much to say that commercial and trade decay lay before them unless they could pull themselves together in this matter. They pottered over night schools, and this or that piece of technical teaching. They were altogether on a wrong scale. Where their competitors were spending thousands of pounds they were spending dozens of half-pence.

SCIENTIFIC SERIALS.

Memoirs of the Kazan Society of Naturalists, vol. xxxii. 1, 2, 3.—The fauna of the Eocene deposits on the Volga between Saratov and Tsaritsyn, by A. Netschaev, with ten plates. These deposits were formerly described as Cretaceous. It was Prof. Sintsoff who determined their Palæocene age, and established their subdivisions, lately confirmed and further studied by Prof. Pavloff. The author describes 170 species from his own collections, out of which species no less than 80 are new, or are described as such. Three subdivisions of the deposits are established, corresponding to the following subdivisions previously described: (*a*) the sands Pg_1c of Sintsoff, or Lower Sarmatian, of Prof. Pavloff, which would correspond to the Suessonien of Western Europe, or to the Thanet Sands of Great Britain: (*b*) the Glauconite sandstones, Pg_1a' of Sintsoff, or Upper Syzrañ of Pavloff, and the Glauconite clays and sandstones, Pg_1a of Sintsoff, or Lower Syzrañ of Pavloff, the latter overlying and gradually passing into the Cretaceous strata. On the whole, these Eocene strata bear resemblance to the Anglo-Gaelic deposits of the same age, but totally differ from the Eocene deposits of South-west Russia. The Palæocene Volga Sea must have been a large sea extending northwards up the present lower Volga, and westwards as far as the meridian of Penza. In the East, it reached the foot of the Southern Urals. This sea was a remainder from a much larger Cretaceous sea, which covered a large part of European Russia. The Middle and Upper Eocene sea which covered South-west Russia must have been independent from the former.—Materials for the flora of the Buzuluk district of Samara, by D. Yanishevsky. A list of 644 phanerogam species is given.—On the deformed skulls found in the Siberian burial mounds (*Kurgans*), by S. Tschugunoff (with one plate). This is the ninth note of the author's "Materials for the Anthropology of Siberia," the first eight notes having been published in the *Proceedings* of the Tomsk University, parts vi., vii. and x. The author describes two macrocephalic deformed skulls which were found in the Kainsk district of Tomsk, as well as three others of the same type from the Crimea.

Bollettino della Società Sismologica Italiana, vol. iii., 1897, No. 5.—Obituary notice of M. S. de Rossi, by A. Cancani.—Principal eruptive phenomena in Sicily and the adjacent islands, January-June 1898, by S. Arcidiacono.—Elastic pendulum to act mechanically on the *Galli-Brassart* informer, by C. Guzzanti. The new arrangement consists of a pendulum, the movement of which, magnified by a lever, stops the clock of the informer.—The Turkestan earthquakes of August 15 and September 17, 1897, by G. Agamennone.—List of earthquakes observed in Greece during the year 1895 [first half], by S. A. Papavasiliou: a list of about 250 shocks, nearly one-half of which were felt in the island of Zante.—Notices of earthquakes recorded in Italy (September 21-October 2, 1897), by G. Agamennone, the most important being the Ancora earthquake of September 21.

Memoirs of the Society of Naturalists of St. Petersburg: Mineralogy and Geology, vol. xxiv.—Geological observations in the valleys of the Urukh, Ardon, Malka, and the neighbourhoods of Kislovodsk, by M. Karakash. The above valleys are occupied in their upper parts by granites and crystalline slates, followed by palæozoic clay slates. Granites crop out next, once more, and are covered with Lower and Upper Cretaceous deposits, followed further northwards by Tertiary deposits. Near Kislovodsk, Senonian, Albian, Aptian, and Lower Neocomian deposits were found.—The fauna of the Jurassic deposits of Mangyshlak and Tuar Kyr (Transcaspian region), by B. Semenoff, being a study of the fossils collected by Prof. Andrusov in that very little explored region (with plates). The fossils belong to the Callovian age. At Tuar Kyr two new species (*Macrocephalites Andrussowi* and *Peltoceras retrocostatum*) were discovered, as also two Himalayan species (*Cosmoceras Theodorii*, Opp., and *Peltoceras cf. Ruprechti*, Opp.) This discovery would seem to give support to Neumayr's idea as to the Jurassic basins of West Europe and Russia having been connected with the Himalayan sea through a Transcaspian basin.—On geological researches made in 1895 in the government of Baku and on the Eastern coast of the Caspian Sea, by N. Andrusov.—New data relative to the fauna of Jurassic deposits in Orenburg, by B. Semenoff. They are based on the collections kept at the St. Petersburg University. Twenty-eight supra-Jurassic Ammonites (26 *Perisphinctes* and 2 *Aspidoceras*) were studied; they belong to various ages, from the Upper Oxfordian to the Tithonian age.—All papers are fully summed up in French or in German.

Memoirs of the St. Petersburg Society of Naturalists: Botany, vol. xxvii. Parts 2 and 3.—These two Parts are almost entirely given to larger works relative to local floras: the flora of the Polyesié (the Woodlands of West Russia), by I. Pachosky, followed by a note on the Woodlands of Volhynia, by S. Fedoséeff; the flora of the government of Pskoff, by N. I. Puring (with map), followed by a note by E. Ispolatoff; and a paper on the flora of Novgorod, by A. I. Kolmovsky.—A note on the structure of the stem of *Gypsophila aretioides*, by V. Dobrovlyansky, with two very interesting photographs.

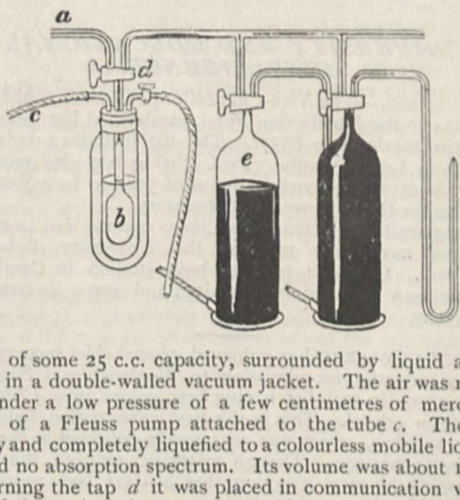
SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 15, 1898.—"The Preparation and some of the Properties of Pure Argon." By William Ramsay, F.R.S., and Morris W. Travers.

In order to prepare 15 litres of argon, it is necessary to deal with about 1500 litres of atmospheric air, of which approximately 1200 litres consist of a mixture of nitrogen and argon. To absorb the nitrogen contained in this quantity of gas by conversion into nitride, 4 kilograms of magnesium would be required theoretically; but, in order to cover loss through leakage and incomplete action, 5 kilograms of the metal were employed. The absorption of the oxygen and nitrogen was conducted in three stages. In the first, the oxygen was removed by means of metallic copper; in the second, the nitrogen was passed twice over metallic magnesium; and in the third, the gas, now rich in argon, was finally freed from nitrogen and hydrogen by passage over a mixture of anhydrous lime and magnesium powder heated to a red heat, and subsequently over red-hot copper oxide. The method of preparation is described in detail in the original paper.

This argon was then liquefied in an apparatus which is represented in the figure. The argon entered through the tube *a* into the



bulb *b*, of some 25 c.c. capacity, surrounded by liquid air contained in a double-walled vacuum jacket. The air was made to boil under a low pressure of a few centimetres of mercury by means of a Fleuss pump attached to the tube *c*. The argon rapidly and completely liquefied to a colourless mobile liquid; it showed no absorption spectrum. Its volume was about 17·4 c.c. By turning the tap *d* it was placed in communication with the first of the series of mercury gasholders, *e*; the reservoir was then lowered so as to remove the lower-boiling portions of the liquid. During this distillation, which took place at constant temperature, the pressure on the boiling air was kept as low as possible. This gas subsequently turned out to be rich in neon, and to contain helium (*Roy. Soc. Proc.*, vol. lxiii. p. 437). The remainder of the argon boiled back into the main gasometer until the last few drops were left; the residue solidified, and finally gave a gas to which we gave the name metargon; it was collected in mercury gasholders (*loc. cit.*, p. 439). As will be subsequently shown, the krypton and xenon in this quantity of argon are too minute for detection. A similar operation for the purpose of separating the lighter as well as the heavier constituents was afterwards repeated three times, the middle portion of argon being always returned to the main gasholder. A fourth liquefaction was carried out in which six mercury gasholders were filled with six separate fractions of argon, each taken after each successive fifth of the total argon had evaporated. These fractions were next purified from any nitrogen accidentally present by sparking with oxygen over caustic potash. After the removal of the oxygen the density was determined.

Density of Argon.

For a preliminary determination of the density of the various samples a bulb of about 33 c.c. capacity was employed. It is much easier to ensure the purity of a small sample of gas than of a large one; and it will be seen that very concordant determinations are obtainable with a small quantity. The limit of error is probably not greater than one part in a thousand. The results are expressed in terms of O = 16.

	Capacity of bulb. c.c.	Temp.	Pressure. mm.	Weight. gram.	Density.
(1)	32·762	19·05°	535·1	0·03786	19·65
(2)	,,	15·70	712·0	0·05265	19·95
(3)	,,	17·00	662·2	0·05012	19·95
(4)	,,	14·55	749·8	0·05460	19·91
(5)	,,	15·60	740·4	0·05389	19·97
(6)	,,	16·15	760·2	0·05501	19·95

The spectrum of No. 4, examined later, showed a trace of nitrogen; the density of No. 6 was confirmed by other two determinations, each made after further sparking.

No. 1 was the first portion boiled off, and therefore its density is lower than that of the other fractions, probably owing to its still containing some neon and helium. The rest of the samples have a constant density, approximately 19·95.

A larger quantity of No. 5 was then purified by long-continued sparking, and its density was determined in a bulb of greater capacity. To show the influence of such purification, results are given, obtained before it was complete. The gas under such conditions showed a trace of the nitrogen spectrum. The portion last weighed was spectroscopically pure.

Capacity of bulb. c.c.	Temp.	Pressure.	Weight.	Density.
163·19	15·47°	767·1	0·27235	19·935
,,	16·97	764·8	0·26985	19·914
,,	13·34	742·8	0·26591	19·952
,,	12·95	741·3	0·26586	19·961

After the first of these determinations the gas was passed over a mixture of red-hot magnesium and lime, and subsequently over red-hot copper oxide, in order to remove hydrogen. But after determining the density, the gas was examined spectroscopically, and was found to contain hydrogen. The gas was therefore again sparked, when the density 19·952 was found. This specimen was also examined spectroscopically, and was found to be absolutely free from all visible traces of impurity. The last weighing refers to the same sample of gas, and was made as a control experiment.

These results conclusively prove that the density of argon, purified from its companions, does not differ greatly from that obtained by Lord Rayleigh, viz. 19·94, nor by one of us, viz. 19·941. The true density may, we think, be safely taken as the mean of the last two determinations, viz. 19·957.

This corresponds with the mean of the four trustworthy determinations with the small bulb, viz. Nos. 2, 3, 5, and 6, which is 19·955.

Refractivity of Argon.

The refractivity of pure argon was next determined. The measurements were made according to the plan suggested by Lord Rayleigh (*Roy. Soc. Proc.*, vol. lix. p. 201). The samples investigated were Nos. 1, 2, 5, and 6. The comparison was made with air.

(1) 0·9620 Contains neon and helium.
(2) 0·9687
(5) 0·9647 Mean, 0·9665.
(6) 0·9660

The refractivity of a previous sample of argon, obtained from the middle of the 15 litres, during the second liquefaction, was 0·9679, a number differing only slightly from that given above.

The refractivity of argon containing krypton, which had a density 20·01, was much higher than the number given above for pure argon, for it reached 1·030 as a mean of two determinations. Evidently then the body possessing the high refractivity was not present in No. 6 in greater proportion than in No. 2, otherwise the refractivity of No. 6 would have shown an increase over that of No. 2.

The refractivity of pure argon differs somewhat from the value for crude argon found by Lord Rayleigh, viz. 0·961 (*Roy. Soc. Proc.*, vol. lix. p. 205), and also from that previously found by ourselves, 0·9596. The removal of neon, which appears to have a very low refractivity, and of helium, of which the refractivity is 0·1238, accounts for the increased refractivity of a sample from which they are absent. The gases which we have recently found in air and in crude argon will form the subject of a future communication. Suffice it to say that the amount of neon and helium is much more considerable than that of the others, and that their effect on crude argon is, therefore, much more marked on its density and refractivity.

The change in its physical constants, caused by the mixture of more recently discovered gases which it has been shown to contain, is therefore exceedingly small, and does not call for any serious alteration in the original paper on "Argon, a new Constituent of the Atmosphere."

The Density of Argon at the Boiling Point of Oxygen.

In an addendum to the original paper on argon (*Phil. Trans.*, A, 1895, p. 239), the expansion of argon by rise of temperature to 250°, as well as its contraction by fall of temperature to −88°, was determined. There is a considerable difference between the temperature at which nitrous oxide boils and that at which oxygen boils, and it was thought worth while to ascertain whether argon behaves as a normal gas down to the boiling point of oxygen. Olszewski (*loc. cit.*, p. 257) gives the boiling point of argon as −187°, and that of oxygen as −182·7°; at the latter temperature, therefore, argon would not be far removed from its own condensing point. The interesting question, of course, is the possible polymerisation of argon at such a low temperature.

No sign of any polymerisation has been observed, as is shown by the following data:—

Temperature. °C.	Pressure. mm.	Volume.	R.
Hydrogen Thermometer.			
99·7	1091·5	1·0026	2·9362
0·0	803·2	1·0000	2·9421
−182·7	269·6	0·9953	2·9715
Argon Thermometer.			
100·1	1414·9	1·0026	3·8095
0·0	1040·0	1·0000	3·8022
−182·7	353·2	0·9953	3·8930

No correction has been made for the unheated or uncooled stem of the thermometer; but it is obvious that although the lowest temperament lies close to the boiling point of argon, the ratio of the values of PV/T of hydrogen and argon at that temperature, as well as the others, is practically constant.

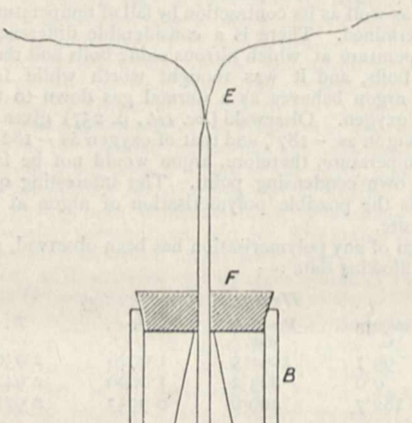
"On the Boiling Point of Liquid Hydrogen under Reduced Pressure." By James Dewar, F.R.S.

The June number of the *Proceedings* of the Chemical Society contains a paper by the author on "The Boiling Point and Density of Liquid Hydrogen." A resistance thermometer made of fine platinum wire, called No. 7 Thermometer, was used in the investigation. It had been carefully calibrated, and gave the following resistances at different temperatures:—

Temperature.	Resistance. Ohms.
+99·1° C.	7·337
+75·3	6·859
+51·4	6·388
+25·7	5·857
+0·7	5·338
−78·2	3·687
−182·6	1·398
−193·9	1·136
−214·0	0·690

These numbers suggest that with the resistance reduced to zero, the temperature registered by the thermometer ought to be −244° C. At the boiling point of hydrogen, therefore, if the law correlating resistance and temperature can be pressed to its limits, a lowering of the boiling point of hydrogen by 5° or 6° C. would produce a condition of affairs where the platinum would have no resistance, or become a perfect conductor. Now we have every reason to believe that hydrogen, like other liquids, will boil at a lower temperature the lower the pressure under which it is volatilised. The question arises, how much lowering of temperature can we practically anticipate?

Calculations lead to the conclusion that, as the absolute boiling point under atmospheric pressure is 35°, ebullition under 25 mm. pressure ought to reduce the boiling point some 10° C. For some time experiments have been in progress with the object of determining the temperature of hydrogen boiling under about 25 mm. pressure, but the difficulties encountered have been so great, and repeated failures so exasperating, that a record of the results so far reached becomes advisable. The troubles arise from the conduction of heat by the leads; the small latent heat of hydrogen volume for volume as compared with liquid air; the inefficiency of heat isolation, and the strain on the thermometer brought about by solid air freezing on it and distorting the coil of wire. In many experiments the result has been that all the liquid hydrogen has evaporated before the pressure was reduced to 25 mm., or the thermometer was left imperfectly covered. The apparatus employed will be understood from the figure. The liquid hydrogen collected in the vacuum vessel A was suspended in a larger vessel of the same kind B, which is so constructed that a spiral tube joins the inner and outer test tubes of



which B is made, thereby making an opening into the interior at C. The resistance thermometer D and leads E pass through a rubber cork F, and the exhaustion takes place through C. In this way the cold vapours are drawn over the outside of the hydrogen vacuum vessel, and this helps to isolate the liquid from the connective currents of gas. To effect proper isolation the whole apparatus ought to have been immersed in liquid air under exhaustion. Arrangements of this kind add to the complication, so in the first instance the liquid was used as described. The liquid hydrogen evaporated quietly and steadily under a pressure of about 25 mm. of mercury without the least appearance of solidification or loss of mobility; still remaining clear and colourless to the eye. Naturally the liquid does not last long, so the resistance has to be taken quickly. Just before the reduction of pressure began, the resistance of the thermometer was 0·131 ohm. This result compares favourably with the former observation on the boiling point, which gave a resistance of 0·129 ohm. On reducing the pressure, the resistance diminished to 0·114 ohm, and kept steady for some time. The lowest reading of resistance was 0·112 ohm. This value corresponds to −239·1° C., or only one degree lower than the boiling point at atmospheric pressure, whereas the temperature ought to have been reduced some 10° C., or in any case 5° under the assumed exhaustion.

No blunder having been detected in the observations, for the present we must assume that the platinum resistance thermometer No. 7 acts in the manner described. It would be premature to discuss the inferences to be drawn from these results until they are confirmed on another variety of platinum wire made into a resistance thermometer. But as this will involve the use of considerable quantities of liquid hydrogen, it will take some time to complete the investigation.

The same kind of anomaly appears in the case of the use of a thermo-junction at these low temperatures; but this is a separate matter, and must be dealt with in a further communication.

Linnean Society, December 15, 1898.—Dr. A. Günther, F.R.S., President, in the chair.—On behalf of Captain John Marriott, two crustaceans were exhibited which had been procured by him on a recent journey to the Sinai Peninsula, and had been identified as *Grapsus maculatus* and *Panulirus penicillatus*. A brief account of the distribution and habits was given by Mr. Harting. The Rev. T. R. Stebbing referred to a well-known case of *P. penicillatus* in the Paris Museum, exhibiting the singular monstrosity of an eye-stalk developing a flagellum or lash-like termination, an observation which he thought had not been confirmed. Prof. Howes remarked that the ophthalmite if removed had been proved to regenerate as an antenniform appendage, by Herbst in *Palaemon* ("Archiv. f. Entwickelungsmechanik d. Org.," Bd. ii. p. 544), and by Hofer in *Astacus fluviatilis* ("Verh. Deutsch. Zool. Gesellsch.," 1894, p. 82).—Mr. Thomas Scott communicated a description of some marine and freshwater crustacea from Franz-Josef Land, collected by Mr. W. S. Bruce, of the Jackson-Harmsworth Expedition. The Rev. T. R. Stebbing, who gave the substance of the paper in the absence of the author, considered the collection an important one. The number of species amounted to 173, comprising Macrura 5 species, Schizopoda 2, Cumacea 5, Isopoda 5, Amphipoda 46, Ostracoda 34, Copepoda 66, and Cirripedia 2. Of these 173 species 12 were new.—Mr. H. J. Elwes, F.R.S., gave an account of the zoological and botanical results of a recent journey to the Altai Mountains. The journey commenced practically at Moscow in the middle of May, and extended from the Ural Mountains through Omsk to the River Obi, across a vast and unvarying steppe to Büsk, where his natural-history collecting began. After describing the general appearance of the country and the vegetation, Mr. Elwes stated that he had brought home about 180 species of butterflies out of a possible 200 (of which 141 had been collected by himself), and 80 species of moths. As regards plants, finding the flora pretty well known through the labours of Ledebour, Bunge, and Tchihatcheff, he thought it preferable to collect the plants of a small typical valley rather than attempt a general collection made at random. Unfortunately, owing to an accident when crossing a river, the greater part of that collection was lost. He was much struck with the extraordinary beauty and abundance of the alpine plants in certain marshy valleys from 6000 to 7500 feet in altitude. There was a remarkable absence of peat-plants, and hardly any ferns were seen in the Tchuja valley between the Katuna River and the upper Tchuja steppe, a plateau about 6000 feet above the sea, south of which the greater part of the observations were made. From this plateau he journeyed to the high mountains of the south in quest of the famous wild sheep, *Ovis ammon* of Pallas, of which he secured three specimens, which were now exhibited, one having a measurement of 62 inches round the curve of the horn, which is about the largest on record for this species. He mentioned the scarcity of game-birds in the Altai, though *Tetraogallus altaicus* was often seen at an elevation of 8000–9000 feet, accompanying the ibex (*Capra sibirica*) as in the Himalaya and Caucasus. He mentioned the breeding on the mountain lakes of *Oidemia Stejnegeri*, a North Pacific species allied to our velvet scoter. The great stag of the Altai, of which several heads were shown, was evidently an Asiatic form of the wapiti, the antlers having a remarkably long fourth tine, and the peculiar back tine at the top, characteristic of the American animal, and not observable in the European red deer. These were compared with four adult pairs of horns of the Mantchurian *Cervus Lühdorfi*, which had been kindly sent to him by the Duke of Bedford. Though much smaller than either the American or Altai stag, these horns showed the same typical wapiti character, and it appeared as though the races inhabiting the N.W. coast of America and the N.E. coast-region of Asia more closely resembled each other than they did the other races of their own continent. He exhibited a series of heads of the Siberian roedeer, which were compared with typical heads of the European roedeer, from which it was considered specifically distinct. A discussion followed, in which Mr. J. G. Baker and Dr. O. Stapf criticised at some length the character of the flora of the Altai, Dr. W. T. Blanford and Colonel Godwin-Austen commented upon the mammalia collected by Mr. Elwes, and Sir George Hampson gave some statistics relating to the lepidoptera.

Mathematical Society, January 12.—Prof. Elliott, F.R.S., Vice-President, and subsequently Lieut.-Colonel Cunningham, R.E., Vice-President, and Dr. Hobson, F.R.S., in the chair.—The following papers were read, or communicated in abstract:—Linear transformation by inversions, Dr. G. G. Morrice.—The zeroes of the Bessel functions (No. ii.), by Mr. H. M. Macdonald.—A simple method of factorising large composite numbers of any unknown form, by Mr. Biddle.—On a determinant each of whose elements is the product of *k* factors, Prof. Metzler.—Properties of hyper-space, in relation to systems of forces, the kinematics of rigid bodies, and Clifford's parallels, Mr. A. N. Whitehead.—On the reduction of a linear substitution to its canonical form, Prof. Burnside, F.R.S.

EDINBURGH.

Royal Society, January 9.—Sir William Turner, Vice-President, in the chair.—Dr. Thomas Muir communicated a paper on the determination of a single term of a determinant.—In a paper on the energy of the Röntgen rays, the Rev. A. Moffat gave an account of some experiments recently made by him in Erlangen. The energy was determined by photometric comparison of the luminescence of the fluorescent screen with a standard candle, and the result was in fair agreement with that obtained by Dorn by a calorimetric method. The discharge was obtained from a Töppler influence machine—a fact which probably explains the shortness of duration of the Röntgen discharge (1/100,000 sec.) as compared with the duration obtained by Trouton, Roito, and other experimenters who used the induction coil.—Dr. R. Broom communicated a paper on the development and morphology of the marsupial shoulder-girdle, which contained an examination of the early stages of development in the common Phalanger, the Ring-tailed Phalanger, and the Rock-Wallaby. Among the conclusions arrived at were the following: (*a*) The well-developed coracoid in the fœtal marsupials, and consequently the coracoid process in the higher mammals, is the homologue of the posterior coracoidal element in the Monotremes and Theromorphs and of the coracoid in reptiles generally. (*b*) The epicoracoid in Monotremes and Theromorphs is the homologue of the precoracoid of the amphibia. (*c*) The only representative of the precoracoid remaining in the higher mammals is the coraco-clavicular ligament.—Prof. Tait, in a note on the hydrokinetic equations, pointed out how the introduction of unit volume of the fluid as a factor of the whole, led to a definite interpretation of each term separately. The interpretation took a curious form in the case of vortex motion.

PARIS.

Academy of Sciences, January 16.—M. van Tieghem in the chair.—The Centenary of the Imperial Military Academy of Medicine of St. Petersburg, by M. d'Arsonval.—On the general course of vegetation, by M. Berthelot. The amount of moisture was determined in different parts of the same plant (*Cynosurus cristatus*), grown in sunlight and in the shade. The plant developed in the shade contains the largest quantity of water.—On the anomalous dispersion of incandescent sodium vapour, and on some consequences of this phenomenon, by M. Henri Becquerel. Incandescent sodium vapour shows an abnormal dispersion for radiations near the lines D_1 and D_2. The index of refraction of the vapour can be clearly shown to be less than unity for radiations of wave-length near to D_1 and D_2. A confirmation is also given of the experiment of M. Voigt, who from theoretical considerations based upon the Zeeman effect concluded that a sodium flame, placed in a magnetic field and traversed by a polarised luminous bundle, ought to show double refraction analogous to a crystallised plate, and in a direction perpendicular to the magnetic field. The phenomenon results from a superposition of the Zeeman effect and abnormal dispersion.—On the treatment of tuberculous abscess, by M. Lannelongue. As an alternative to extirpation, a method of multiple injection is described, the active ingredient in the fluid injected being iodoform.—Results of meteorological observations made in the depression at the centre of Asia (Luktshoun), by M. Alexis de Tillo.—Solar observations made at the Observatory of Lyons, with the Brunner equatorial during the third quarter of 1898, by M. J. Guillaume.—On the variation of density in the interior of the earth, by M. du Ligondès.—On a new slide rule, by M. G. Gallice. This calculating rule is designed for the use of navigators, and by its use problems of nautical astronomy can be rapidly solved.—On the complete integrals of some partial differential equations, by M. N. Saltykow.—Loss of electricity by evaporation of electrified water. Application to atmospheric electricity, by M. H. Pellat. A surface of electrified water, having a surface density slightly greater than that of the earth, loses a portion of its charge on evaporation at the ordinary temperature, but this effect is not sufficient to explain the diurnal variation.—On the transmission of sounds by ultra-violet rays, by M. Dussaud. A modification of the ordinary selenium radiophone, in which ultra-violet rays act upon the selenium cell through a fluorescent substance.—On a physical method of deciding whether dispersion occurs in a vacuum or not, by M. L. Décombe. It is proposed to study the relative velocities of light wave and the electrical oscillations produced by a Hertz exciter.—On the optical properties of the invisible residual luminescence, by M. Gustave Le Bon. Ordinary solar light and the invisible light emitted by phosphorescent bodies possess absolutely identical properties. This residual luminescence completely disappears after a time.—On the source of energy in radio-active bodies, by Sir William Crookes. The suggestion is put forward that uranium and thorium, substances possessing heavy atoms, may have such a structure as to be able to abstract energy from the more rapidly moving air particles, without being affected by the slower air particles: a partial realisation, in fact, of Clerk Maxwell's "demon."—On the peroxidation of cerium dissolved in alkaline carbonates, by M. André Job. Cerium salts dissolved in alkaline carbonates may exist in three states of oxidation, corresponding to Ce_2O_3, CeO_2, and CeO_3.—Triacetylmorphine and the oxidation of morphine, by M. H. Causse. It is shown that a triacetyl-derivative can be obtained from morphine, and that one atom of oxygen is probably present in a ketonic group, CO.—On the ether-chlorides of dibasic acids, by M. E. E. Blaise.—The assimilation of carbohydrates and the elaboration of organic nitrogen in the higher plants, by M. Mazé.—On the Ordovician rocks of Crozon, Finisterre, by M. F. Kerforne.

AMSTERDAM.

Royal Academy of Sciences, December 24, 1898.—Prof. J. A. C. Oudemans in the chair.—Prof. Bakhuis Roozeboom communicated the results of Dr. Van Eyk's inquiries into mixture crystals of KNO_3 and $TlNO_3$. This is the first time that the progress of the solidification and the relation between the composition of a liquid mixture and a solid one has been studied with respect to all concentrations from 0 to 100 per cent. From 0 to 20 per cent. and from 50 to 100 per cent. the mixture crystals, subsiding from the melted substance, contain KNO_3. Between 20 and 50 per cent., a conglomerate of the two limiting mixture crystals is deposited. The transition of all these mixture crystals from the rhombohedrical to the rhombic form has also been studied. This transition is a very complicated process, though it has been found entirely to correspond with the theory lately given by the author. While in the case of $TlNO_3$ the transition takes place at 144°, and in the case of KNO_3 at 129° in the case of mixture crystals it is only completed at 108°. In the rhombic form, too, there is a hiatus in the mixing from 40 to 84 per cent. of KNO_3, which becomes still greater towards a lower temperature.—Prof. Van der Waals made a communication on volume contraction and pressure contraction (ii.), being a continuation of a communication made by himself at the previous meeting, and discussed the course of the magnitude Δ_p. The author demonstrated that even in those cases in which the magnitude was positive, if the mixing took place at low pressure, reversion of the sign was to be expected when the pressure, at which the mixture took place, was very great.—Prof. Kamerlingh Onnes presented (1) a paper by Dr. J. Verschaffelt on determinations concerning the course of the isotherms in the case of a mixture of carbonic acid and hydrogen, in the proximity of the plait point; (2) a paper by Dr. L. H. Siertsema, entitled "Measurements on the magnetic rotatory dispersion of gases." As a continuation of his communications on this subject (*cf. Proc.*, September 1896), the author gives some more details and plates of the apparatus, with a discussion of the results obtained.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 26.

ROYAL SOCIETY, at 4.30.—Contributions to the Theory of Simultaneous Partial Differential Equations: Prof. A. C. Dixon.—On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. III. On *Medullosa anglica*, a New Representative of the Cycadofilices: Dr. Scott, F.R.S.—On the Nature of Electro-Capillary Phenomena. I. Their Relation to the Potential Differences between Solutions: S. W. J. Smith.

ROYAL INSTITUTION, at 3.—Tibet and the Tibetans: A. Henry Savage Landor.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains: J. Pigg.—The Regulation of Wiring Rules: C. H. Wordingham.—The Institution Wiring Rules: R. E. Crompton.

FRIDAY, JANUARY 27.

ROYAL GEOGRAPHICAL SOCIETY, at 4.—The Sub-Oceanic Physical Features off the Coast of Western Europe, including France, Spain, and Portugal: Prof. Edward Hull, F.R.S.

PHYSICAL SOCIETY, at 5.—On the Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge: Dr. Edwin H. Barton.—Exhibition of (*a*) a Dephlegmator; (*b*) a Temperature Tell-Tale: R. Appleyard.—On the Volume Changes accompanying Solution: T. H. Littlewood.

INSTITUTION OF CIVIL ENGINEERS, at 8.—King's Lynn Water Works: F. C. Grimley.

SATURDAY, JANUARY 28.

ESSEX FIELD CLUB (Technical Institute, Stratford), at 6.30.—Exhibition of Geological Photographs (Lantern) brought together by the British Association Committee: T. V. Holmes.

MONDAY, JANUARY 30.

SOCIETY OF ARTS, at 8.—Bacterial Purification of Sewage: Dr. Samuel Rideal.

IMPERIAL INSTITUTE, at 8.30.—West Africa: Miss M. H. Kingsley.

TUESDAY, JANUARY 31.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Centenary Exhibition of Lithographs, with Remarks on Further Developments of the Art: Edward F. Strange.

ROYAL MINERALOGICAL SOCIETY, at 8.—Experiments with Zeolites: Prof. A. H. Church, F.R.S.—Analyses of Ceylon Apatite: by the same.—On a New Mode of Occurrence of Ruby in North Carolina: Prof. J. W. Judd, C.B., F.R.S., and W. E. Hidden; with Crystallographic Notes by Dr. J. H. Pratt.—On the Constitution of the Mineral Arsenates and Phosphates. II. Pharmacosiderite: E. G. J. Hartley.—On the Chemical Composition of Binnite: G. T. Prior and L. J. Spencer.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Papers to be further discussed: The Effects of Wear upon Steel Rails: William G. Kirkaldy.—On the Microphotography of Steel Rails: Prof. Roberts-Austen, K.C.B., F.R.S.—And, time permitting: The Waterworks of the Madras Presidency: J. A. Jones.

WEDNESDAY, FEBRUARY 1.

SOCIETY OF ARTS, at 8.—The Cost of Municipal Enterprise: Dixon H. Davies.

GEOLOGICAL SOCIETY, at 8.—On Radiolaria in Chert from Chypon's Farm, Mullion District, Cornwall: Dr. G. J. Hinde, F.R.S.—Gravel at Moreton-in-the-Marsh (Gloucestershire): S. S. Buckman.—On the Occurrence of Pebbles of Schorl-Rock from the South-West of England in the Drift Deposits of Southern and Eastern England: A. E. Salter.

THURSDAY, FEBRUARY 2.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Sets of Operations in relation to Groups of Finite Order: A. N. Whitehead.—Note on the Enhanced Lines in the Spectrum of α Cygni: Sir J. Norman Lockyer, F.R.S.—On the Effects of Strain on the Thermo-Electric Qualities of Metals: Dr. Magnus Maclean.—The Constitution of the Electric Spark: Prof. A. Schuster, F.R.S., and G. Hemsalech.

ROYAL INSTITUTION, at 3.—Tibet and the Tibetans: A. H. Savage Landor.

LINNEAN SOCIETY, at 8.—Notes on the Genus Nanomitrium, Lindberg: E. Stanley Salmon.—On the Production of Apospory by Environment in *Athrium Filix-foemina*, var. *unco-glomeratum*, an apparently Barren Fern: Dr. F. W. Stansfield.—On the Genus Lemnalia, Gray, with an Account of the Branching System of the Order Alcyonacea: Gilbert C. Bourne.

CHEMICAL SOCIETY, at 8.—(1) Maltodextrin, its Oxidation Products and Constitution; (2) On Attempts to prepare Pure Starch Derivatives through their Nitrates: Dr H. T. Brown, F.R.S., and J. H. Millar.—An Isomeride of Amarine: Dr. H. Lloyd Snape and Dr. Arthur Brooke. Propylbenzenesulphonic Acids: Dr. G. T. Moody.—Derivatives of Dibenzylmesitylene: W. H. Mills and T. H. Easterfield.—On the Action of Chlorosulphonic Acid on the Paraffins and other Hydrocarbons: Dr. Sydney Young, F.R.S.—(1) The Action of Reducing Agents on Nitrogen Iodide; (2) The Action of Acids upon Nitrogen Iodide: F. D. Chattaway and H. P. Stevens.—The Composition of Nitrogen Iodide: F. D. Chattaway.—(1) The Preparation and Properties of Nitrogen Iodide; (2) The Action of Light upon Nitrogen Iodide; (3) The Action of Alkaline Hydrates, of Water, and of Hydrogen Peroxide upon Nitrogen Iodide; (4) Theory of the Formation and Reactions of Nitrogen Iodide: F. D. Chattaway and Kennedy J. P. Orton.

FRIDAY, FEBRUARY 3.

ROYAL INSTITUTION, at 9.—The Roman Defences of South-East Britain: Prof. Victor Horsley, F.R.S.

GEOLOGISTS' ASSOCIATION, at 7.30.—Annual Meeting.—Address by the President, J. J. H. Teall, F.R.S.

QUEKETT MICROSCOPICAL CLUB, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Sketch of the Evolution of our Native Fruits: L. H. Bailey (Macmillan).—Handbook of Metallurgy: Dr. C. Schnabel, translated by Prof. H. Louis, 2 Vols. (Macmillan).—Traité de Zoologie Concrète: Y. Delage and E. Hérouard, Tome viii. (Paris, Schleicher).—Among the Himalaya: Major L. A. Waddell (Constable).—Untersuchungen über Strukturen: Prof. O. Bütschli, Text and Atlas (Leipzig, Engelmann).—Dictionnaire Technique: H. S. Lovendal (Paris, Boyveau).—Ostwald's Klassiker der Exakten Wissenschaften, Nr. 101 and 102 (Leipzig, Engelmann).—A Short History of Astronomy: A. Berry (Murray).—River Development: Prof. I. C. Russell (Murray).—The Temple of Mut in Asher: M. Benson and J. Gourlay (Murray).—Zoological Results: Dr. A. Willey, Part 2 (Cambridge University Press).—A Treatise on Photographic Optics: R. S. Cole (Low).—The Native Tribes of Central Australia: Prof. B. Spencer and F. J. Gillen (Macmillan).—The Book of the Master: W. M. Adams (Murray).—An Intermediate Text-Book of Geology: Prof. C. Lapworth, new edition (Blackwood).—Photo-micrography: E. J. Spitta (Scientific Press).—Gordon in Central Africa: edited by Dr. G. B. Hill, new edition (Macmillan).—Fertilizers: Prof. E. B Voorhees (Macmillan).—Mathematical Tables, Wrapson and Gee (Macmillan).—The Marine Steam-Engine: C. Busley, translated by H. A. B. Cole, 3rd edition, 2nd Part (Grevel).—Annuaire de l'Observatoire Royal de Belgique, 1899; and ditto, Supplément to 1898 (Bruxelles).—A Class-Book of Physical Geography; Prof. W. Hughes: Revised, &c., by R. A. Gregory (Philip).—Pubblicazioni della Specola Vaticana, Vol. v. (Roma).—An Introduction to the Mathematical Theory of Attraction: Prof. F. A. Tarleton (Longmans).—The Testing of Materials of Construction: Prof. W. C. Unwin, 2nd edition (Longmans).—Creation Myths of Primitive America: J. Curtin (Williams).—Outlines of Industrial Chemistry: Dr. F. H. Thorp (Macmillan).

PAMPHLETS.—The World's Exchanges in 1898: J. H. Norman (Low).—A Course of Lectures on Mining: Prof. W. Galloway; Colliery Explosions (Cardiff).—"Representative Indians" in Court, or What is Authorship?: Sastri and Pillai (Madras).

SERIALS.—Natural Science, January (Pentland).—Himmel und Erde, January (Berlin).—An Illustrated Manual of British Birds: H. Saunders, 2nd edition, Parts 13 to 15 (Gurney).—American Journal of Science, January (New Haven).—Beiträge zur Biologie der Pflanzen, viii. Band, 1 Heft (Breslau).—Transactions of the English Arboricultural Society, Vol. iv. Part 1 (Carlisle).—Educational Review, January (203 Strand).

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