THURSDAY, JANUARY 20, 1910.

LORD KELVIN'S EARLY LIFE.

Lord Kelvin's Early Home. Being the Recollections of his Sister, the late Mrs. Elizabeth King; together with some Family Letters and a Supplementary Chapter by the Editor, Elizabeth Thomson King. Pp. xii+245. (London: Macmillan and Co., Ltd., 1909.) Price 8*s*. 6*d*. net.

THIS fascinating volume gives us a vivid picture of the home life of the remarkable family into which Lord Kelvin was born eighty-five years ago. It is mainly the work of his eldest sister, Mrs. Elizabeth King, who kept many notes and casual diary records, and it has been lovingly edited by her daughter, who has added a brief supplementary chapter. Of that family Lord Kelvin was the last survivor.

Its head was James Thomson, born in 1786, the son of a farmer in county Down, who died in 1849 when professor of mathematics in Glasgow University. His "forbears" had come more than a century before from Ayrshire in the "killing time" of Claverhouse, and the farm on which they settled remained in their possession until 1847, when James Thomson's eldest brother was obliged to leave it for Belfast in the distressful days of the Irish famine.

James Thomson was the Benjamin of the country farmhouse. There were four older children, the youngest ten years older than him. His sister taught him to read, "using handkerchiefs with mottoes and verses printed on them composed by the patriots who brought about the rebellion of 1798." He taught himself arithmetic from a dilapidated copy of Bonycastle, with which he fortunately fell in, "not only mastering its contents, but supplying many pages that were wanting." While still very young he was sent to a day school, and he had no other teaching until he went to Glasgow College. Everything about the boy helped him to educate himself. There was an old sundial in front of the house which fascinated him, and which he tried to reproduce. But his new dials failed to tell the time of day. One very hot summer night, as he lay awake thinking on the problem in his bed out in a garden-house, the theory of dialling dawned on his mind, and he soon worked it out until he was able to make sundials to be placed horizontally, perpendicularly, or at any angle whatever. Some of the dials he made then still exist.

He came across the narrow seas to Glasgow College, as many Irish boys used to do before the Queen's Colleges were set up about 1846. He spent many winters there, taking his M.A., going through most of the medical classes, and the complete theological course with a view to entering the ministry. But when he left the university he was appointed teacher of arithmetic and geography in the newly established Royal Belfast Academical Institution. In a short time it became a college, having preparatory schools connected with it, and it was the forerunner of Queen's College, Belfast. James Thomson was appointed professor of mathematics in the college, in addition to his work in the school. He had found his vocation.

Some time after, when he was thirty-one years of age, he married Margaret Gardiner, daughter of a prosperous Glasgow merchant. She had come across the year before to visit a cousin, Dr. Cairns, a colleague of Dr. Thomson's in the institution. She became engaged to Dr. Thomson, and was married the year following. Their wedding journey was through the Highlands. The Scotch bride settled in Belfast, and died there after twelve happy years of married life. James Thomson brought the motherless family of six children to Glasgow University when he was appointed professor of mathematics in 1832. The eldest daughter, Elizabeth, whose notes and recollections are the basis of the book, was fourteen when they came to Glasgow; the youngest, Robert, was three. They had been seven in number when their mother died. After her death, and before they went to Glasgow, the youngest girl, named after her mother, faded and died. Mrs. Thomson's younger sister, Agnes, who had herself married in 1826, was left in charge of the family, and brought them over to their new home. The family were Elizabeth, aged fourteen; Anna, aged about twelve; James, aged ten; William, aged eight; John, aged six; and Robert, aged four. This younger sister, Agnes—Mrs. Gall—had been brought up in Glasgow by the elder sister, Mrs. Thomson, and felt for her the warm affection of a daughter.

The sixteen years in Belfast, with the young family growing about his knees, were perhaps the most epoch-making of his life. No family ever owed more to their father and mother. For many years, says the eldest daughter, they had no other teacher, except for French and writing, music and dancing. Dr. Thomson

'was in the habit of rising at four to work at his books. Some coffee and cream and a spirit lamp having been put ready for him, he made himself a cup of hot coffee before beginning. In these quiet morning hours he got through an immense amount of work before his professional duties began. His books on arithmetic, mathematics, geography, &c., went through very many editions which constantly needed revising and bringing up to date, so that he was occupied with them more or less to the end of his life. As professor of mathematics, during the winter months he lectured every morning from eight till nine, and from eleven to twelve in the forenoon. In the afternoon he was occupied with his school classes, and these ended he regularly went to the news room and the commercial buildings for a little while. Our mother was always waiting for his return, with the children about her. Very eagerly we listened for his knock, and ran to the door, and helped him to take off his things, and then heard some stories from him of what was going on in the world. After dinner we children came down again, and a bit of bright burning cannel coal was put on the fire, which blazed up and filled the room with dancing light; the globes were placed on the table, and we gathered round; little Willie and sometimes James also on the table beside the globes while our father explained their use and taught us to work out problems in them. William was scarcely four when he began to take some part in these cheerful after-dinner lessons, and from the very first he showed the wonderful mental capacity with which he was endowed. What lovely memories rise up as I recall that dear fireside of long ago—our father and mother sitting there among us."

All his life Lord Kelvin used to testify that his father had taught him everything he had learned until he went to college in Glasgow. Here is another picture of the family:—

"It was the next winter that James (then eight) and William (then six) were first sent to some classes in the Institution for an hour or two in the day, and the delightful after-dinner lessons and readings with our dear father were continued with ever increasing profit and pleasure. As we dined at half-past four and the meal was quickly despatched, we had long evenings with him. He gathered us about him, and in every way strove to supply the place of our lovely mother. He was indeed both father and mother to us, and watched over us continually. William was a great pet with him, partly perhaps on account of his extreme beauty, partly on account of his wonderful quickness of apprehension, but most of all, I think, on account of his coaxing, fascinating ways, and the caresses he lavished on his 'darling papa.' When his father stooped to greet him the child would fling his arms about his neck, and smother him with kisses and stroke his cheeks endearingly. . . . I do not remember that any of us were ever in the slightest degree jealous of William on account of our father making him a little more a pet than the rest of us. We were proud of him, and indeed we thought the child petted the father even more than the father petted the child; but we saw plainly that the fondling of his little son pleased him. Willie always slept in a small bed in our father's room—that is, after his early nursery days—because he had for some years a tendency to sleep-walking, which for a time caused some anxiety."

Prof. Thomson's first session at Glasgow brought something of a disappointment. In those days there was no arrangement for a pension when, through age or infirmity, a professor retired. The outgoing professor often made a private arrangement with the new-comer. Lord Kelvin's sister tells us that under such an arrangement his father actually had at first to pay his predecessor more than the chair brought in.

"To mitigate the loss, he announced an afternoon course of lectures for ladies on geography and astronomy, to be given twice a week in his class-room. Such a thing had never been heard of before in the university, and it was extremely popular. The large class-room was crowded in every corner, and it was a novel and interesting spectacle to see bench rising above bench filled with fashionably dressed ladies, every one looking intent, and many taking notes. All the belles of Glasgow were among the students. This class was carried on for two or three years with undiminished popularity till the pressure of other engagements compelled my father to give it up, the regular mathematical class becoming so large as to give him quite as much work as he could overtake."

New arrangements also were made with his predecessor, and the ladies' classes had to be given up. The children's education continued to occupy the father's time.

"We did not go to school, but our father, as hitherto, took the general supervision of our lessons. William and James began Latin with him on the Hamiltonian system, and made rapid progress. They also attended the junior mathematical class as listeners, without being examined or writing the exercises. In a letter to William, dated May 7, 1886, Mr. Wallace, an old student of our father's, writes:—'It was in a very large class that as a mere child (ten years old then) you startled the whole class, not one of whom could answer a certain question, by calling out, "Do, papa, let me answer." The impression on my mind has never been effaced.'"

Mrs. King writes again:—

"Our first summer in Scotland was spent at Rothesay, and there our father devoted himself indefatigably to our education. Every morning the four elder children—ages fifteen, thirteen, eleven, nine—spent some hours with him in his study, and always after lessons he took us out for a walk, and made the walk a daily pleasure with his varied converse."

Next session—1834—the aunt, Mrs. Gall, had to leave them to join her husband, and Elizabeth, now a girl of sixteen, became mistress of the house. It is most interesting to follow the course of their studies. The two girls read Latin (Cæsar's Commentaries)

"with our father during his breakfast—our own porridge and milk having been despatched earlier. The two boys, James and William, went in the morning to college classes—the girls taught their two younger brothers piano, and writing, arithmetic, geography, also a little French and Latin, and read Goldsmith's History of England. Nor was poetry neglected in this course of study. I got books from the college library to read about painting and about the lives and works of the old masters. After dinner our father gave us a short mathematical lesson, and after that he read aloud to us. During this winter he thus read the whole of Pope's Iliad and Odyssey, several of the plays of Shakespeare, those also of Goldsmith and Sheridan, besides selections from the old poets. William had the strongest sense of humour of any of us, and not only enjoyed it himself, but set all the little party laughing mirthfully whenever a humorous passage occurred. Mrs. Malaprop and Bob Acres, &c., were most inspiring. Whilst our father read, Anna and I sewed—not fancy work, but flannel petticoats and the like—and our brothers lay on their backs on the floor with their arms extended, to give them a rest and help them to grow straight. The reading was followed by a lively tea, after which our father returned to his study, the two youngest children were taken up to bed, and the four elder adjourned to the drawing-room. James and William were attending Dr. Cooper's natural history class, and in the evenings they retailed their lectures to their sisters after tea. William was not ten till the following June. I was James's pupil, and Anna was William's. About 9 o'clock James and William went to bed, and Anna and I went down to the study to our father, who took down a book and read to us—sitting on two stools at his feet. It was often the Spectator or Rambler that he chose for this purpose—sometimes Blair's Sermons, which he considered pure English as well as profitable reading. In about half-an-hour we said good-night. A servant always came for our candle and took it to him that he might know that we were snug in bed."

"I think it was about the end of 1836, when William was twelve, that James and William made electrical machines for themselves, having become much interested in the study of electricity at the natural philosophy class. James's machine was larger and more carefully finished than William's, but William's, though rather rough, served every purpose to his own satisfaction. They made them entirely themselves. The chief thing that I remember is the frequent shocks to which the family in general were subjected, and the collecting of electricity in their large Leyden jars. But their work was really serious, and was continually expanding. They went on to make voltaic piles and galvanic batteries, experimenting with metals and fluids, and on light and heat, and magnetic electricity. Soon William's attention was turned to the polarisation of light, and he pursued experiments in this field of inquiry with extraordinary eagerness and delight. The brothers contrived and themselves made most if not all of the apparatus they used in their experiments."

"Their happy winter workdays were pleasantly varied with summer rambles. Dr. Nichol, the famous professor of astronomy, had taught these classes in natural philosophy during the illness of the professor, and in summer he took James and William a two or three days' ramble over the volcanic region of the Siebengebirge, climbing the Drachenfels on their last morning."

All science was their province. Lord Kelvin always claimed that natural philosophy comprehended all the sciences.

"Before setting out on our travels in 1840," his sister writes that "William had got Fourier's 'Théorie analytique de la Chaleur' from the college library, and when studying the book one day he suddenly sprang from the stool on which he was sitting and excitedly exclaimed, 'Papa, Fourier is right and Kelland is wrong.' Our father was rather incredulous, but on examination he found that in the points in which Kelland had declared Fourier mistaken it was Kelland himself who was mistaken and not Fourier. He made the boy write an article for the Cambridge Mathematical Journal, and sent it to Gregory, the editor. It was shown to Kelland before it was published. At first he was very much annoyed, but after some expressions had been altered he was satisfied to let it appear. I may add that Kelland became very friendly with William, and as long as he lived the friendship continued."

In 1841 William went to Cambridge, and the story of his life there is well known.

"A brilliant university career was before him. He was also distinguishing himself as an oarsman. A nice second-hand 'funny' came in his way, which he did not lose the opportunity of securing. It was 27 ft. long, painted blue, and bordered with a band of gilding. It was decked or covered all over except a hole in the middle, where the rower sat, and it was so light that William could carry it himself if need were. He called it the 'Nautilus.' He became as enthusiastic in boating as he was in everything he set about, and he won many prizes in the races. Like a jockey, he used to regulate his food so as to form good strong muscle without increasing his weight. . . . When he won the Silver Sculls, it was better, he declared, than winning an examination."

The story of his second wranglership and subsequent first Smith's prizemanship has often been told. When the first list came out he writes to his sister that the principal thing he cared about in the result was the disappointment he was afraid papa must feel, "as I am afraid he had rather raised his hopes about it, though I tried to keep him from expecting too much before the examination, as I knew the uncertainty."

Next year came welcome compensation. At the age of twenty-two William was elected professor of natural philosophy in Glasgow, to the chair which he made so famous during the half-century of his occupation. It was delightful, for his father, now his colleague, was becoming frail. He died of cholera in Glasgow two years and a half later. But he had seen in his declining years the splendid outcome of his long life-work. James Thomson's numerous text-books were excellent in their day. They had an enormous circulation, and were of the utmost service in the education of the time. But his greatest work was his teaching of his own family. While his most enduring monument is the splendid fame of Lord Kelvin and his elder brother, James Thomson, he did work not less memorable in shaping and developing the beautiful lives of all the six children, to whom he was father and mother in one. It was in that warm and loving home that Lord Kelvin and his brothers and sisters found the intellectual and moral nourishment that made them what they came to be in their day and generation. W. J.

PROTOPLASM IN HARNESS.

Les Zoocécidies des Plantes d'Europe et du Bassin de la Méditerranée. By Dr. C. Houard. Two vols. (I. 1908, II. 1909). Pp. xvi+1248. (Paris: A. Hermann et Fils.) Price, two vols., 45 francs.

GALLS on plants, in at least the more conspicuous forms, must have been known to man from a very early period in his history, and the presence in them of living animals might have been expected to suggest inquiries as to their source and relation to plants, yet even after Malpighi had published the results of his study of various galls, and had been followed by Reaumur in his admirable "Mémoires," the interest in those curious growths long remained limited to a very few. To botanists they were little more than excrescences on, or defects of, plants, lessening their value as specimens, while zoologists were rarely attracted to the study of the makers, which belonged for the most part to mites, nematode worms, midges, and other groups difficult to study, and little attractive in themselves.

But the latter half of the nineteenth century was marked by an almost sudden outburst of activity, about 1870, led by Drs. F. Thomas, D. von Schlechtendal, F. Löw, G. Mayr, and others, resulting in numerous papers filled with descriptions of previously unknown galls, and gall-makers, and with life-histories disclosing new relations between plants and animals, as well as new cycles of development of the animals. Such discoveries as the surprising dimorphism so general among the Cynipidæ that gall the oaks attracted keen interest, which showed itself in an increase of workers, and in a more and more rapid advance in the study of galls, especially in faunistic researches, and in more accurate determinations of the gall-makers and of the influence on one another of host and parasite.

The diversities in structure among galls (the alterations induced by the gall-producers in some cases amounting only to slight enlargement of the parts involved, while in others they result in bodies of complex nature and definite specific forms), and the systematic relations among the numerous gall-bearing plants, and also among the gall-producers, support the belief that the power to affect the protoplasm so as to lead it to produce structures useful to the gall-makers has been acquired independently by numerous organisms (plants as well as animals), in widely different grades of development. If that is so, it seems reasonable to expect that power to control the activity of protoplasm will, at least to some extent, be acquired by man, and may produce results of great value. Although as yet experiments have thrown little light on the artificial production of galls, there is a very attractive field open for research in this direction.

Since 1870 an extensive literature has appeared dealing with galls, dispersed so widely that much of it was almost beyond reach of even keen students in this field. In 1858 G. von Haimhoffen estimated the known galls of Europe at from 300 to 350. In Kaltenbach's "Planzenfeinde," issued in 1873 and 1874, the galls of Central Europe formed by insects, and by a few mites, were described under the host-plants; and from 1890 to 1895 D. von Schlechtendal issued a catalogue of the galls of animal-origin then known to occur in Germany.

In 1901 appeared two works giving brief descriptions of the galls of Europe and of the Mediterranean area, Kieffer's "Synopsis des Zoocécidies d'Europe," and Darboux and Houard's "Catalogue systématique des Zoocécidies de l'Europe et du Bassin Méditerranéen." These were most welcome, and stimulated research so greatly that a new catalogue had already become necessary when M. Houard supplied the need by his latest work, "Les Zoocécidies des Plantes d'Europe et du Bassin de la Méditerranée." Based upon the "Catalogue," and covering the same area, comparison of the two shows remarkable progress during the few years that elapsed between their dates of issue. Such a comparison is a little hindered by the host-plants being arranged in the earlier list in alphabetical order of the generic and specific names, while in the later they are in families, these following the order in Engler's "Pflanzenfamilien," while within each family the genera and species are grouped after Nyman's "Conspectus Floræ Europeæ." The advantages derived from the re-arrangement of the host plants beside their allies far outweigh those of the alphabetical arrangement.

The comparison between the individual hosts in the two lists shows very careful revision of the descriptions common to both, the omission from the second of some forms included in the first, the definite reference to their makers of numerous galls previously of unknown or doubtful origin, and the addition of many recently discovered galls, some on plants already known to bear galls, others on new hosts. A rough indication of the advance is given in the rise of the marginal numbers attached to the galls from 4169 to 6239; but perhaps a truer value is afforded by the increase of the host-plants in much the same proportion, and of the known gall-makers from 1072 to 1366 species, the increase being especially large among the Curculionidæ (beetles), the Cynipidæ (gall-flies), the Cecidomyidæ (gall-midges), and Eriophyidæ (gall-mites). Numerous additions have been made to the very useful illustrations scattered through the book.

An important addition is a bibliography of the literature on galls, which, though not complete, is the best that has yet been published, and will be found most helpful as a guide, while its value is increased by references to it under each gall; and the countries in which the galls have been found are also indicated very briefly, yet simply. Under each host-plant the galls are arranged on the same method as was employed in the "Catalogue systématique," viz., terminal galls of fruits, flowers, stems, and buds, followed by lateral growths on roots, stems, branches, leaves, &c. In most cases this method makes it possible to ascertain the name of any gall without serious difficulty; but on some of the oaks and a few other plants the forms are so numerous as to lead to further subdivision of the groups by subordinate characters.

The arrangement of the plants in families has allowed a brief but suggestive outline of the leading features of the galls characteristic of each family, and of occasional suggestions for inquiries.

Careful indexes of the host-plants and of the gall-makers add greatly to the usefulness of the book, and the typography is excellent. It is, in a very literal sense, indispensable to all students of galls, while those interested in the problems as to the nature of living matter and its responses to stimuli will find in its pages much matter for further investigations.

ELECTRICITY ON THE FARM.

Électricité agricole. By A. Petit. Pp. 424. (Paris: J. B. Baillière et Fils, 1909.) Price 5 francs.

THIS book is one of the sixty volumes of the "Encyclopédie agricole," published under the editorship of M. Wery, the scope of which is well summed up in the introduction:—

"Extraire de notre enseignement supérieur la partie immédiatement utilisable par l'exploitant du domaine rurale et faire connaître du même coup à celui-ci les données scientifiques définitivement acquises sur lesquelles la pratique actuelle est basée."

It is in no sense a popular exposition of the principles of electricity, but is rather written for the intelligent farmer who knows something about electricity and also about engineering, and is enterprising enough to investigate the merits of a new suggestion.

The first chapter is devoted to a recapitulation of the general principles and the system of units employed. No attempt is made to dispense with technical expressions; "connaître le vocabulaire d'un art, c'est déjà connaître cet art." The modes of transforming mechanical into electrical energy are then discussed in a very interesting chapter, the sources of energy dealt with being water power, steam, oil, and wind. Of all these wind would be by far the best if electricity had to be generated on the farm itself, but the difficulties are considerable. Attempts have been made in this direction particularly by M. La Cour in Denmark, whose trials are perhaps the most complete yet made, and who has demonstrated the possibility of utilising wind if there is also some subsidiary source of power. But the subject is by no means exhausted, and the utilisation of the energy of the wind still remains one of the most fascinating problems in agricultural engineering. The transmission of the current is next described. In this chapter, as in the preceding one, there are a number of diagrams to illustrate the principle of the apparatus, besides a good deal of information that will be useful when anything goes wrong. These chapters take up half the book.

The author then comes to the very important subject, How can electrical energy be utilised on the farm? The two applications developed in detail are the driving of engines and lighting. Its use for driving the machinery in the farm buildings, the chaff-cutter, the pulper, and so on, is obvious, but the author goes still further and describes a number of applications which as yet have only rarely been made. Some forty pages are devoted to electrical ploughing, the first attempts at which were made so far back as 1879, although as a practicable method nothing was done until 1894, when a start was made both in Italy and in Germany. The methods are almost exactly the same as for steam ploughing; indeed, the idea is taken direct from the steam plough but electricity is substituted for steam as the hauling power. In one system there are two electric motors at opposite ends of the furrows hauling the plough; in the other an anchor is used and there is one motor only. The problem here is really very simple; if steam ploughing is known to be beneficial electric ploughing will be equally so, and the question resolves itself solely into the relative cost of the power. Indeed, this statement holds true of most of the applications recommended by the author. His electrical threshing machine, for instance, is the ordinary machine driven by electrical power, so also are the refrigerating machines, pumps, and sawmills.

The application of electricity as a source of light affords a great deal of scope for the author's ingenuity, since many of the farm operations, such as the milking and feeding of dairy cows, have to be carried out before daylight during part of the year. Suitable lamps are suggested for the various buildings.

There is also a useful chapter on treatment of accidents caused by electricity and precautions to be taken in order to avoid accidents. Lastly we have some well-illustrated descriptions of farms where some of these applications are in actual use. Probably to the English reader this is the most interesting chapter of all. Whether we may expect to see electricity utilised on British farms is another matter. Up to the present electricity has simply been taking the place of steam to work the old implements originally designed for human or horse labour. Probably before it comes into common use in agriculture our implements will have to be re-modelled and adapted to electrical power. In the cases described by the author water power is available or electric current is being transmitted through the district. The farmer can calculate exactly how much his power will cost him and whether it is worth while replacing the oil engine by a motor.

The book forms a useful contribution to agricultural engineering, and will make very suggestive reading for the thoughtful agriculturist.

THE PHENOMENA OF THE EARTH'S SURFACE.

Physiography for Schools. By R. D. Salisbury. Pp. viii + 530. (London: John Murray, 1909.) Price 6s. net.

THIS book may be looked on as a reduction of the advanced course by the same author. Prof. Salisbury states in his preface that he differs from other writers on physical geography "as to the points upon which emphasis should be laid and the objects to be attained." But it would require careful reading to find out in what matters of principle this text-book differs from others by American authors, and we fancy that schools will adopt one book or the other rather from some attraction between the teacher and the author than from any preference as to mode of treatment. We miss the "cycle of erosion," and its accompaniment, the "peneplain," which have taken quite an affectionate hold upon our minds; but we meet the "mesa" and the "monadnock," and the really awkward adjective "piedmont," this last being used without explanation, and applied to certain plains as well as glaciers.

Valley-forms are agreeably dealt with as expressions of youth, maturity, or old age, and the excellent chapter on the "Work of Running Water" may be taken as typical of the first part of the book. We should not like to spare any of its numerous maps and illustrations, which bring before us all manner of details in the history of a stream; at the same time, we should like to hear more from the author, whose lines are modestly dovetailed in between them. A specially effective feature of part i. is the insertion of some twenty contoured maps in colour, often on a scale of one inch to one mile, selected from the topographic sheets of the United States Geological Survey. With this example before us, must we wait long for a European work, similarly illustrated from our British contoured maps, and also, perhaps, from the 1:200,000 sheets of the Austrian Military Institute?

The later parts of the book, on "Earth Relations," "The Atmosphere," and "The Ocean," do not lend themselves so temptingly to illustration; but numerous diagrams and charts are given, and the instruction in the text is singularly clear. Fig. 351, showing how the length of a degree is related to polar flattening, requires more thought than a child is likely to bring to bear on it. Perhaps a diagram showing how longer distances have to be traversed as we go northward, in order to shift the altitude of the pole star by so many degrees, might have been simpler, in illustration of the description on the following page. Snow crystals are named "snowflakes" in the title of Fig. 176; and Fig. 450 shows the sounding-tube, and not the line, as stated. We fear that the abrupt question to the reader, "Why not use a rope, instead of a wire, in sounding?" may be taken as a suggestion from the gifted author, and may turn the young mind in a wrong direction. But there is little to criticise in this closely-written text-book. We return to the pages on the work of rivers and of ice with special pleasure. The author thinks (p. 168) that plastic flow does not play any real part in glacier motion, and lays stress on the re-freezing of water that has sunk from above into the ice-mass. The recently published work on glacial phenomena in the Bighorn Mountains has been promptly utilised, and one of the fine cirques, though not our own favourite picture, is shown on p. 179. Chapter xix., on the relations of plants and animals to their environment, has been contributed by Dr. Cowles and Mr. C. C. Adams. G. A. J. C.

OUR BOOK SHELF.

An Atlas of Absorption Spectra. By Dr. C. E. K. Mees. Pp. 74. (London: Longmans, Green and Co.; Croydon: Wratten and Wainwright, Ltd., 1909.)

ALL scientific workers who have had occasion to employ colour-sensitive photographic plates during the last few years will probably have wished at some time to learn some details as to the specially great advances made in their preparation. Also for the efficient use of the plates suitable screens or colour-filters are required to equalise the action of the various colours. Dr. Mees, as director of the firm of Wratten and Wainwright, has had exceptional facilities in dealing with these matters, and in publishing this atlas he is giving others the benefit of his work. The spectra were taken on the spectrum panchromatic series of plates, which, in addition to the usual region of maximum sensitiveness in the violet, show another maximum near λ 6500 in the red, with gradually decreasing action to λ 7500. To obtain as even records as possible, two schemes were adopted:—(1) For the spectra of dyes an equalising screen of special composition, with two cells of mandarin-orange and P-nitrosodimethylaniline, was used with a Nernst lamp; in the case of special dyes the spectra were photographed in two sections for convenience; in front of the slit a wedge-shaped cell was fitted containing the dye solution, with a similar cell filled with pure water the opposite way to compensate for any prismatic effect. By this means the light passed through varying thicknesses of absorbing medium from end to end of the slit, and the resulting spectra show curves bounding the absorption bands which indicate graphically the change in absorption with varying thickness of dye. (2) For the spectra of the colour-filters the wedge cell could not be employed, and in its place a black wedge of specially prepared glass was used. This gave a range of intensity from 1 to 10,000.

The atlas contains reproductions of the spectra of 170 dye-stuffs, most of them obtained from the Hœchst Farbwerke, and of 76 colour-filters prepared by Messrs. Wratten and Wainwright for various purposes, which are clearly stated. All the photographs are scaled in wave-lengths, so that by mere inspection the exact range of any absorption may be ascertained. A concise index is given, including the name of dye, concentration, source, whether it is acid or basic, and a scale of numbers representing the relative stability to light. Series of monochromatic filters are supplied and illustrated, which practically isolate a very small portion of the spectrum in each case, these being suitable for work requiring great precision in the wave-length of light employed.

Physiology of Man and Other Animals. By Dr. Anne Moore. Pp. xiii+212. (New York: Henry Holt and Co., 1909.) Price 80 cents.

THIS little book is intended for the use of children in schools; about half of it is devoted to elementary physiology, and the remainder to elementary zoology. The author has the gift of putting things clearly, and in a manner likely to interest the young. She, however, very soon gets out of her depth, and often makes mistakes of the most elementary nature. This is particularly noticeable when she speaks about the nervous system or strays into the region of chemical physiology. There is no clear distinction made between the central and the peripheral nervous system, and no mention made of the functions of the brain as the organ of mind; the depressor nerve is stated to cause slowing of the heart, and the sympathetic nerves, we are told, received their name because of their extreme sensitiveness.

Her definition of osmosis would not be acceptable to any physicist or physiologist; she has not even grasped the distinction between internal and external respiration. We are told that carbon dioxide stimulates the respiratory *muscles* to action; that the secretion of the sebaceous glands is a part of the secretion of the sweat glands; that lipase is the most important ferment of the pancreatic juice; that peptones are absorbed and pass to the liver; that fats are hydrocarbons; and that the formula for starch is $C_6N_{12}O_6$. Such examples of glaring errors are quite sufficient to show that the book cannot be recommended as a safe guide to those who have passed childhood, and even for children it seems a pity that some degree of exactness should not be aimed at.

Deutsche Südpolar-Expedition, 1901–1903. Bd. ii. Geographie und Geologie. Heft 5. Pp. 348–410; pls. xxviii–xxx. (Berlin: Georg Reimer, 1909.) Price 8 marks.

THE German South Polar Expedition called for a few hours at the islands at St. Paul and New Amsterdam, and though in so short a visit but little fresh information was obtained, one of the valuable by-products of the expedition is a useful summary and discussion of all that is known about these islands. New Amsterdam was discovered in 1522 by Sebastian del Cano, who commanded Magellan's expedition after his death at Manila. Both islands are French possessions. They are both solely volcanic, and rise from a common base. New Amsterdam is composed only of basalt, while St. Paul consists of basalt with some rhyolite tuffs and obsidian. The memoir on the geography of the islands is by Dr. von Drygalski, on the geology by Philippi, and on the petrology and the relations of the lavas to those of Kerguelen, Possession, and Heard Islands by Reinisch. E. Vanhöffen contributes a catalogue of the flora and of the fauna, which consists only of insects, myriapods, spiders, tardigrades, crustacea, rotifers, &c. The memoir has three excellent plates illustrating the scenery and volcanic features.

Les Progrès récents de l'Astronomie (1908). By Prof. Paul Stroobant. Pp. 115. (Brussels: Hayez, 1909.)

EVERYONE interested in the progress of astronomy will welcome the appearance of Prof. Stroobant's annual summary of a year's results, and 1908 was by no means a barren year. Hale's discovery of the Zeeman effect in the solar spectrum, the Flint Island eclipse, the Lowell Observatory observations of the planets and their spectra, the discovery of J viii by Melotte at Greenwich, and the preliminary comet campaign provided by the appearance of 1908 III, are all reviewed in a fashion at once comprehensive and clear. The omissions are few, but we regret to find no mention of the McClean expedition to Flint Island. Four plates illustrate various researches, and the tables of results will be found useful for reference. Although each result appears under a general and a special heading, the addition of an index to this small volume would, we believe, enhance its value.

W. E. R.

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.*]

Cross-fertilisation of Sweet-peas.

It is unnecessary, I think, to cite more than one of the recent statements with regard to sweet-peas, though I can provide others. Sir Francis Galton in his just issued "Memories" (p. 300) writes:—

"After much consideration and many inquiries, I determined in 1885, on experimenting with sweet-peas, which were suggested to me both by Sir Joseph Hooker and Mr. Darwin. Their merits are three-fold. They have so little tendency to become cross-fertilised that seedsmen do not hesitate to grow differently coloured plants in neighbouring beds. . . ."

I must thank Mr. Francis Darwin (p. 308) for his reference to the "Cross- and Self-fertilisation." On the page he refers to Charles Darwin writes:—"Why, then, do not the varieties occasionally intercross, though this would not often happen, as insects so rarely act in an efficient manner?" and again, "Whatever the cause may be, we may conclude, that in England the varieties never or very rarely intercross." These are the views which evidently Charles Darwin communicated to Sir Francis Galton.

My point is that *now* they do intercross, and that varieties cannot with safety be kept in neighbouring beds. Mr. Wright, the superintendent of the Royal Horticultural Society's Garden at Wisley, told an inquirer in 1907, as to his experience *re* sweet-peas, that he had no doubt there was some English insect that cross-fertilised them, and that in trying new sorts the gardeners had to place the rows in different parts of the garden to minimise the risk as much as possible. Charles Darwin, in the passage referred to, says that "on two or three occasions" he saw Megachile in the act of depressing the keel, and he notes that these bees had the undersides of their bodies thickly covered with pollen. My point is that hourly every day these bees came in large numbers; their visits were not occasional, but persistent and effectual; I never saw a hive bee, although they frequently tried, successful. Megachile may, in the course of forty years, have developed the habit much more completely. The purport of my letter was merely to suggest to those growing sweet-peas that there is no security that they will be self-fertilised if Megachile be frequent.

I should like to add that "The Original π" is by no means the first π who has contributed to the columns of NATURE! The π's are a large and talkative species.

π.

The Village Institute and its Educational Possibilities.

The growth of social life in villages during the last few years has been fostered by the erection of village institutes, halls, and reading-rooms, and yearly such institutions are becoming more numerous. Has the educational life of the village been fostered by their growth?

The majority of these institutions cater for games and recreation, together with a supply of reading matter of the daily paper and monthly magazine type. The presence of the latter indicates a desire on behalf of the management or the donor of the institute to devote at least part of the work of the institute to educational purposes. In many institutes the reading-room is little frequented and has the least share of the members' time, whereas the billiard-room, where long visits are the rule, invariably presents a scene of congestion.

To a certain extent the village institute is a replica of the mechanics' institute of the towns and urban districts; both serve as a meeting place for members, and supply opportunities for recreation and self-improvement to them.

The mechanics' institutes were, in their earliest days, the housing place of evening classes in science, art, and languages, but the growth of continuation education has led to the general abandonment of the mechanics' institutes for systematic class instruction and the provision of special buildings. Courses of lectures of a more or less educational character still remain at the mechanics' institutes—remnants of their early educational efforts. The mechanics' institute is a model upon which the village institute might shape its policy and methods, so becoming a centre of educational activity.

As a result, we find that several village institutes, like their town compeers, give courses of lectures. Such subjects as agriculture, horticulture, poultry-keeping, bee-keeping, and other rural industries are so treated, but, generally speaking, the village institutes have never attempted to take up the work of systematic evening education, as the mechanics' institutes did, fitted to the environment of the villager.

The future of an individual is as much a problem for the "powers that be" in a rural community as it is in the urban district, town, or city. This future is not thoroughly and properly catered for by providing the individual with games and recreation to the exclusion of provision for craft-work and intellectual training for his daily work. Why should not the village institute help in the intellectual development of villagers, keeping them mentally elastic and manually efficient by suitable educational work?

If the institute cannot provide suitable educational provision on account of lack of funds, it certainly should not, by its rules of membership or otherwise, be an obstacle in the way of other institutions which take up evening classes.

The younger members of rural communities, as in towns, after leaving day school generally display no further interest in their own education, and their elementary education equipment begins to rust.

In the towns we appeal to the employer to look after the welfare of the youth by asking him to see they attend the evening school. In the villages the same appeal may be made by way of the village institute. The appeal in each case would cease if continuation work became compulsory, but as at present compulsion is not a part of either political party's programme, we must look to other means. It may be said there would be no resting and rusting of the villager if there were an evening continuation school in the village, a statement which brings one to the *raison d'être* of the present letter on village institutes.

The village institute has usually no restrictions concerning the admission of a youth when he applies to become a member. It would not be necessary to advocate a restriction if institute managers had, as a condition of membership, told the would-be member that the institute would be closed to him on those nights the evening school was open. It would not be too drastic to tell the would-be member that up to eighteen years of age he would be expected to attend the evening classes held in the village. In small villages, where the number of available students for an evening school is small, the village institute should render all the help it can. A leading educationist stated before the recent Consultative Committee on Attendance at Evening Schools that there was a club where no boy was allowed to remain a member unless he attended the evening classes two nights per week. The village institutes might take up a similar definite position where evening schools are in existence.

The foregoing suggestions are made because the institute, by providing games, not only threatens the existence or birth of an evening school, but cultivates in its young members no sense of responsibility either to themselves or to the community. A curriculum of pleasure alone should be far from satisfactory for the leaders of village activity.

It may be said that an institute cannot afford financially to cripple itself by the adoption of the foregoing suggestions. My reply is that managers would find that such a regulation, prospective in nature, would not reduce applications for membership. Temporarily there might be a little resistance to the conditions, but in time applicants would become educated to the benefits of such a regulation and recognise it, as they do the payment of a fee. The authority managing the evening school might transfer the fee from the school to the institute if the student made a satisfactory percentage of school attendances. Thus the student would not be mulcted in two payments, one for the school and another for the institute.

It does appear plain that the village institutes have a fine opportunity for giving encouragement to continuation rural education; they not only miss the opportunity, but, at the same time, unwittingly are the cause of there being no demand for an evening school. Opportunities for the village youth to spend aimlessly and uselessly all their spare time are to be deprecated.

In one West Riding village the influence of the opening of a new institute was shown by the total exodus of the members of the existing evening school. Even the moral obligation to complete their attendances, so as to save financial losses upon the school, failed to bring them back again. The billiard-ball was rolling, so opportunities for the making of more fit citizens were sent flying. The result was not a moral triumph for the ex-students.

May one suggest that in the future some donor of an institute, or someone who by their contribution has made it possible for trustees to lease an institute at a nominal rent to a committee of management, should insert a proviso in their deed of gift that younger members of the institute are to attend continuation educational work at the village school? Such a proviso might be open to elimination if found, after an extended trial, to be prejudicial to the institute's success.

There should be an educational side to every village institute; it might be an attached rural association or club for the further advance of rural interests. Such an association might hold meetings periodically for discussions upon general agricultural matters. Samples of manures and feeding stuffs, along with a consideration of current values and prevalent adulterants, are important matters, and should be undertaken by the suggested rural club. The leaflets of the Board of Agriculture would be suitable for elucidation and discussion; their distribution could be carried out by the club.

Village halls have been in the past the centre of the arts and crafts movement; in some parts of the country they are yet. The development of handwork in the elementary schools of the rural districts should again revive the use of the village hall. Such a revival requires funds. The Board of Education and local authorities place at the disposal of committees doing educational work of a manual nature liberal grants. Some of the wealthy trade guilds might be disposed to find funds for a village development of arts and crafts if the work had an industrial basis. In this way might be developed in the village, as in Germany, a large number of small workshops going hand in hand with agriculture.

The village institute and evening school would not become competitors by both taking up educational work; they would become helpers. Admission to the institute's higher work should preferentially be given to those who had thoroughly prepared themselves for it by a satisfactory course of preparatory work at the evening school. In short, the institute would be regarded as the technical school of the village, giving, amongst other work, practical and theoretical instruction on the greatest of all industries—agriculture.

JOHN B. COPPOCK.
(Organiser for the Rural Districts of the West Riding of Yorkshire.)
Education Department, County Hall, Wakefield.

Avogadro's Hypothesis (or Law).

IN Prof. Tilden's "Life of Mendeléeff" in the current number of the Journal of the Chemical Society, I see that he refers repeatedly to the "law" of Avogadro. Sir William Ramsay, in his "Modern Chemistry," speaks of it as a "hypothesis," and this has surely been, until recently, the practice of chemists.

I think there is a growing tendency to speak of it as a law. This, doubtless, arises from the strong confirmatory evidence provided by modern physical chemistry. It is desirable, in the interests of students and of exactitude in scientific nomenclature, that some decision should be come to as to which term should be used. This may necessitate very careful definition.

A discussion of this matter, in which teachers will give reasons for their choice, should prove of value.

S. H. WOOLHOUSE.
Parmiter's School, Approach Road, Victoria Park, N.E., January 17.

"A Japanese Priest in Tibet."

WHATEVER may be the demerits of Mr. Kawaguchi's "Three Years in Tibet," reviewed in NATURE of January 13, the title of the book is, according to the Eastern habit of reckoning, quite accurate. Mr. Kawaguchi spent part of 1900, all 1901, and part of 1902 in Tibet—three years. A child in Japan, if born on December 31, begins his second year on January 1, and on the succeeding New Year's Day may be regarded as having lived for three years, although he may be only 367 days old!

C. G. KNOTT.
University of Edinburgh, January 17.

STANDARD MEASUREMENT IN WAVE-LENGTHS OF LIGHT.

THE employment of the principle of the interference of two rays of monochromatic light, derived from the same source, one retarded behind the other by having to traverse a longer path, for the production of rectilinear interference bands constituting a scale of half-wave-lengths, has now been brought to such perfection that this highly refined scale may be used for the measurement of short distances or small movements of any description whatsoever. The accuracy is absolute to the tenth part of a scale division, the twentieth part of a wave-length of light, and is actually measurable with the most ordinary micrometer to the one-hundredth of a scale division, corresponding to the two-hundredth part of a wave-length. Now a wave-length of even the grossest radiations employed, those of red light, derived from either cadmium vapour (0·0006438 mm.) or hydrogen (0·0006562 mm.), is a forty-thousandth of an inch, so that the measurable unit is an eight-millionth part of an inch.

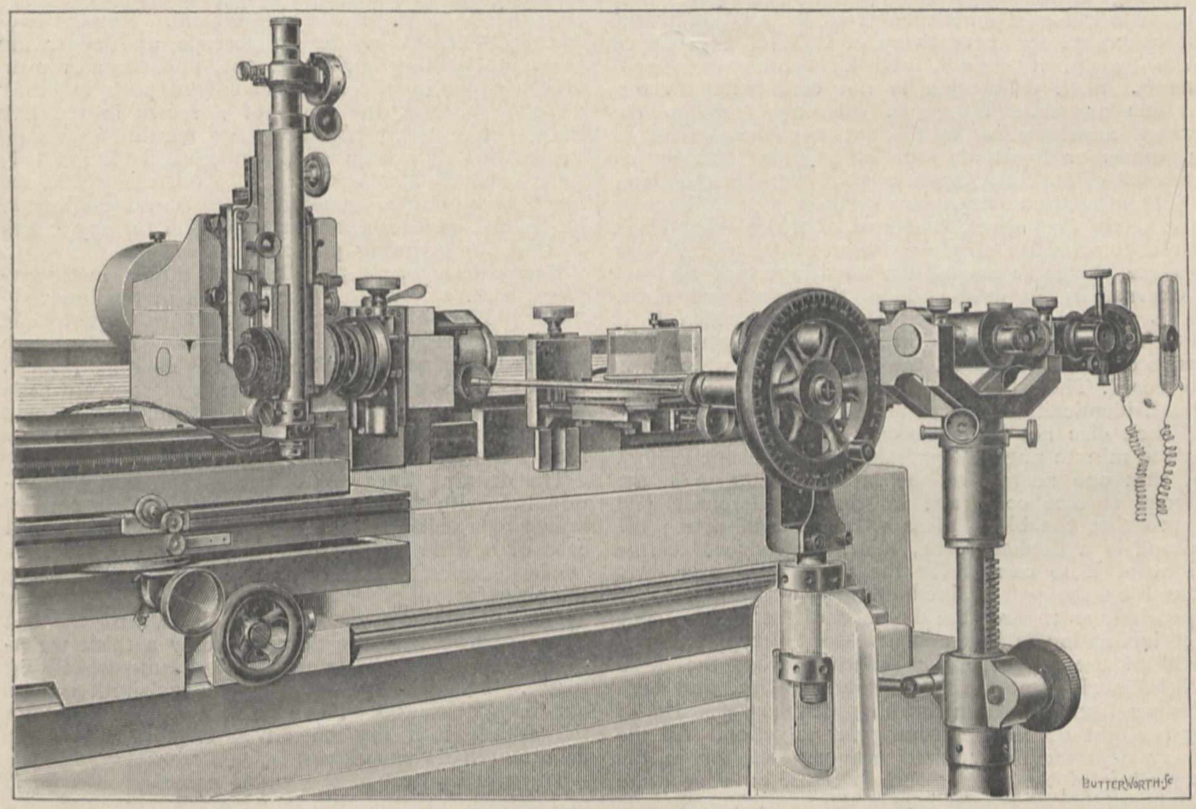
The finest trustworthy measurement by mechanical means (such as the Whitworth machine) or micrometric devices (such as the most refined thickness measurer) is the one-thousandth of a millimetre, or the twenty-five-thousandth of an inch. Moreover, the amount of possible error with either of these mechanical methods of measurement or the interference method is from one to two units of the respective scales. Hence the interference method is only subject to a possible error of one three-hundred-and-twentieth the magnitude of that to which the mechanical mode of measurement is liable.

The interference method was first seriously employed by Fizeau, who utilised it for the determination of the thermal expansion of crystals and other small bodies. It was materially improved by Abbe and Pulfrich, and more recently both for the same crystallographic purpose and for general purposes by the writer, who has also extended its use to the measurement of the modulus of elasticity of crystals and small bodies or small quantities of substances in general.

It will be remembered also that Prof. Michelson, of Chicago, has recently adapted his entirely different mode of producing interference fringes, in this case circular, to the determination of the number of wave-lengths of red cadmium light, which he has proved to be the most homogeneous of all radiations yet known to us, in the French metre. By employing a graduated series of glass-plate *étalons* or intermediate standards, each double of the preceding one, commencing with a basal one of half a millimetre in which the actual number (1212) of half-wave-lengths was counted, the number of wave-lengths of red cadmium light in the metre was eventually found to be 1,553,163. This number has since been confirmed by the independent method of Fabry and Perot, in which circular fringes are also produced.

Three years ago the writer was invited by the Standards Department of the Board of Trade to adapt his interferometer to the purposes of a wave-length comparator of measures of length, and a memoir recently published in the Philosophical Transactions of the Royal Society (Phil. Trans. A, 1910, vol. ccx., p. 1), with the consent of the President of the Board of Trade, describes the instrument, which has now been installed in the Standards Office. The memoir also comprises an appendix concerning the possible employment of wave-length rulings on metal as defining lines on standard bars, with suggestions for their use along with the interference bands of the interferometer, in an original method of determining the total number of wave-lengths in the British yard.

A general view of the interferometer and one of the duplicate microscopes of the comparator, together with sufficient of the bar-carriage to enable some idea of the whole apparatus to be gained, is given in the accompanying illustration.



Central part of comparator, showing interfcmeter.

The whole instrument is mounted on a large stone block, resting on isolated concrete foundations. On a small stone pedestal, similarly isolated, in front of the large block, rests the pedestal of the autocollimating telescope and attached Geissler tube of the interferometer. In the common focal plane of the telescope objective and eye-piece, opposite the junction of this main optical tube with the rectangularly attached side-tube carrying the Geissler tube, a small totally reflecting prism is arranged, half covering the focal aperture. A still smaller rectangular stop or opening in a plate in front of and almost touching that one of the perpendicular prism faces which is directed towards the objective, and lies in the focal plane very close to the edge, dividing the closed half from the open half, is the effective source of the interfering light; the rays from the Geissler tube, received on the other face of the right-angled prism, are arranged to fill this stop after reflection from the hypotenuse of the prism. The rays proceed from the stop to the objective, which they are arranged to fill with light, and thence pass out of the telescope as parallel rays, in the path of which the dispersion and interference apparatus is placed. The rays return to the telescope from the latter along practically the same path, but after re-entering the telescope, instead of returning to the little rectangular stop, their origin, they are deflected just sufficiently to one side to form an image of the stop, the same size as the original, in the open semicircular aperture of the focal plane, within a couple of millimetres of the real stop. This closeness to identity of path of the outgoing and incoming rays, and consequent normal incidence on the reflecting glass surfaces of the interference apparatus, is largely responsible for the magnificent field of parallel straight-lined interference bands which the author's interferometer affords, for it fulfils an essential condition for perfect interference.

With the ordinary eye-piece in position, the images of the stop reflected from the various surfaces of the interference apparatus can be focussed, adequately magnified, and viewed during their adjustment to the theoretically ideal positions. But when this eye-piece is replaced by a special one consisting of a Ramsden micrometer combined with an additional lens between the latter and the focal plane, the telescope is converted into a low-power microscope, which focusses simultaneously the interference bands, a little silvered reference ring in the centre of one of the two surfaces reflecting the interfering light, and the micrometer spider-lines. There are two parallel vertical spider-lines; one is adjustable by the left drum-head of the micrometer, so as to be able to set it at any convenient distance from the other in order to include a single band and most of the reference ring between them; and both are moved together by the other (right) measuring drum, in order to be able to determine the band-width and any fraction of a band which may have passed the reference centre.

The dispersion apparatus consists of a Hilger constant-deviation prism, which enables the desired spectrum ray to be isolated from all others, and that alone delivered to the interference apparatus. The rays are deviated exactly at right angles by this prism towards the interference apparatus, the surfaces of which they strike at normal incidence, after which they return through the constant-deviation prism (thus securing double dispersion) to the telescope. The prism is mounted on a divided circle, so that it may be calibrated for the delivery of light of any desired wave-length, if desired, and has numerous adjustments. Such calibration is not essential, however, as the particular image of the origin-stop in the colour corresponding to the spectrum bright line of cadmium or hydrogen can be adjusted visually on removal of the front lenses of the Ramsden eye-piece.

The interference apparatus consists of three circular and thick glass discs, the third of which is of black glass polished an absolutely true plane on its outer surface, which is one of the two important surfaces concerned in the production of the interfering light. It is ground on the back surface, by which it is attached in an adjustable manner to the right microscope of the comparator, the movement of which it is to record. The other two are larger discs of colourless glass, identically similar, the two truly plane surfaces of each disc not being strictly parallel, but inclined at the minute angle of 35 minutes. The left surface of that one nearest to the black glass disc is the second surface concerned in the interference, and approaches the black glass within a millimetre; the second is a duplicate one, merely introduced on the right of it to correct for the slight dispersion produced by the 35′ of inclination, the two being set oppositely as regards the direction of the wedge. The 35′ inclination is just adequate to deflect out of the field of the telescope the reflection from the other (right) surface of the left colourless disc, and both images from the countervailing disc are got rid of by a slight tilt in the rectangular direction. All the many adjustments required are provided for in the mounting of the two colourless discs, on a separate carrier sliding along the face of the upper V-and-plane bed of the comparator.

The apparatus as described up to this point is the interferometer.

The comparator consists of two V-and-plane beds, nearly 7 feet long, of specially homogeneous cast-iron, and worked truly plane with consummate care, together with their contents; they are arranged step-wise, one on the top of the stone block, and the other 7½ inches below and in front. On the upper one slide the two duplicate microscopes, and on the lower one the standard-bar carriage and accessory fine-adjustment fittings. The carriage is given a longitudinal motion, a transverse motion adequate to bring either of the two bars to be compared under the microscopes, as well as fine adjustments for azimuth, height, and level, thus enabling the defining marks on the bars to be readily focussed without touching the microscopes if it is so desired.

Each microscope is carried on a solidly constructed slider on the V-and-plane bed, by which its coarse adjustment for position is effected. The microscope-bearing bracket is not, however, fixed directly to this slider, but to a second one sliding over the first, also with V-and-plane contact, and with the further control of the movement of a cylinder within a cylindrical boring. The fine-sliding is effected by means of a most carefully made screw of fifty threads to the inch, on which the success of the instrument depends, and which carries at its outer end a large milled head for hand rotation, and a worm-wheel of 100 teeth gearing with an endless screw, which can either be rotated by hand by means of a milled head or by means of a shaft and a large wheel seen in front in the illustration. One complete rotation of the latter corresponds to the movement of the microscope and the black glass interference disc to an extent which causes the passage of fifteen interference bands past the reference centre. More than an inch of movement of the circumference of the wheel is necessary to effect the passage of a single band. Two-thirds of the dead-weight of the microscope and slider are taken up by four spring pistons, and the movement of the slider by the screw is only a push in either direction against the walls of a recess in the free slider, there being absolutely no strain anywhere. Hence this movement of the microscope is not only an excessively fine one, but also so steady that the bands pass with a precision which leaves nothing to be desired, and each band may be held for any length of time for counting purposes.

Each microscope is provided with a micrometer eyepiece, with spider-lines arranged as in the interferometer. The fine adjustment is made exceptionally steady and regular. Two sets of objectives are provided, one pair for observing the defining lines in the countersunk wells near the ends of standard bars, with a magnification of 150 diameters, and without penetration of the well by the objective, and the other set for use with the wave-length rulings.

The defining lines, of whatever character, are illuminated (with "critical illumination") by the brilliant image of a distant Nernst lamp, with the aid in each case of a little reflecting prism, a collimating lens, an iris diaphragm, and a glass-plate mirror above the objective, all provided with fine adjustments. This avoids all heating effect on the bars, and the last traces of heat rays are filtered out by a thick water-jacket in front of the lamp and its beam-parallelising lenses. The illumination of the wave-length rulings one-forty-thousandth of an inch apart is excellent with the 1/12th inch dry objectives employed, and the definition truly surprising.

The temperature of the whole comparator room is maintained at the official temperature, 62° F., entirely electrically, both as regards artificial heating and the thermostat, which is original. So sensitive is the latter that the entrance of a person into the room is immediately followed by the extinction of one of the heating lamps to compensate for the extra warmth introduced.

The finest defining lines yet employed on any line-measure bars are those on the platinum-iridium copy of the imperial standard yard. Yet even each of these has a thickness equivalent to fifteen interference bands. The defining lines on the imperial yard itself are three times as coarse. Hence we have now arrived at that stage in the competition between defining lines and refinement of measurement when the latter has far surpassed the former. It was for this reason that the writer took up the investigation of wave-length rulings, with the idea of their possible use as defining lines commensurable with the increased refinement of measurement. Mr. H. J. Grayson, of Melbourne, whose wonderfully fine rulings have recently been much discussed in microscopic circles, has kindly made a number of rulings of 1/40,000th inch fineness, which preliminary experiments indicated as feasible for the required purpose, on polished speculum-metal and platinum-iridium, which appear, particularly the former, perfectly satisfactory. The forty-thousandth of an inch being the wave-length of red hydrogen or cadmium light, the distance between two lines ruled at this interval corresponds to only two interference bands. With the 1/12th inch dry objectives the lines, moreover, are as cleanly cut as spider-lines, and the thickness of a line is less than half a wave-length. Five such lines are ruled in succession, the central one being considered as *the* defining line. A strong finder-line is ruled on each side of the five, and two other strong ones at right angles in order to localise a central part of such a system. It appears perfectly feasible to carry out a stepping-off process for the counting of the total number of wave-lengths of cadmium red light in the British yard, in which such rulings would take the place of the glass plates of the Michelson or Fabry and Perot *étalons*, a base line of the thirty-second part of an inch being first actually counted in bands with the aid of the interferometer, between limits defined by two such systems of rulings. The final fraction of every stage in such a process could be absolutely checked by the interferometer in all cases where Michelson found it possible to do so, that is, so far as interference bands are still visible, about four inches; and, as it has already been proved that the accuracy with the rulings is almost as great as with interference bands, this checking ceases to be as imperative as when only the coarse existing defining lines are available. Hence, the future before these rulings appears likely to be both interesting and important.

A. E. H. TUTTON.

SOME NEW NATURE BOOKS.[1]

(1) IN this series of pleasantly written essays Mr. Larken gives an account of some of those features of English (and Scotch) country districts which usually appeal to nature-lovers. The author's habit of passing lightly from one topic to another but distantly connected with it produces a certain disjointedness of style and some needless repetitions, but, taken as a whole, his book is quite good to read, and his knack of interesting one in a disputed point and then abruptly leaving it unsettled is well calculated to stimulate personal observation on the part of his readers.

When attempting to draw conclusions himself, however, he is less happy, being prone to derive the inherited instincts and habits of an animal directly from the experience of its ancestors. Moreover, one has rather frequent cause to doubt the accuracy of his statements; for example, anyone familiar with the Caligidæ, and the tightness with which they can adhere, either in or out of the water, even to the smooth sides of a glass dish, will certainly question the remark on p. 219 that a salmon "leaps . . . into the air for the purpose of getting rid of the sea-lice which are attached to him." That "the Brimstone is a genuine child of spring" in contrast with the hibernating Vanessid butterflies (p. 244) is contrary to the experience of other entomologists; and "Humming-Birds of New Guinea" (p. 192) should presumably read "Sun Birds of New Guinea," for humming-birds are confined to western America and its islands.

The book is illustrated with a profusion of excellent plates, chiefly from photographs. As the greater part of it is concerned with ornithological matters, it is not surprising to find that the majority of the illustrations are of birds' nests. The plate of the comma butterfly, which we reproduce, is one of a short series of admirable insect studies.

(2) These four little volumes will be useful to those who wish to interest children in natural history. They treat of the varied aspects of their several subjects in a clear and interesting manner, and are well illustrated by plates (both coloured and from photographs) and by figures in the text. One hesitates to criticise such admirable books at such a low price, but the value of some of the plates would certainly be increased if they could be brought more closely into connection with the chapters which they illustrate; and where this is impossible reference should be made to them in the text. Some statement of the scale of

Comma Butterfly. From "Leisure Hours with Nature."

many of the figures would make these much more useful; in chapter ix. of "The Common I Know," where this is particularly needed, it could easily be made by the insertion beside each figure of a line indicating the length of the living specimen. On p. 30 of the same volume the association of two figures of plants drawn to different scales is apt to mislead. But even as they stand we are far from wishing to condemn the figures. Apart from size, they show clearly the salient characters of the objects described; the reproduction of the photographs has been beautifully executed, and the coloured plates are wonderful at the price. We can thoroughly recommend the books for (elementary) school use.

(3) This "collection of literary extracts to accompany a course of nature-study" includes prose and poetry, with a variety of subjects ranging from Ruskin's "Plants" and Thoreau's "Brute Neighbours" to fairy stories such as "The King of the Vipers" and Ruskin's "Visit from the South-West Wind." Several of the extracts are old favourites

[1] (1) "Leisure Hours with Nature." By E. P. Larken. Pp. xv+263. (London: T. Fisher Unwin, 1909.) Price 5*s*.
(2) "The Wood I Know"; "The Meadow I Know"; "The Stream I Know"; The Common I Know." Edited by W. P. Westell and H. E. Turner. Pp. 77 each. (London: J. M. Dent and Co., 1909.) Price 8*d*.
(3) "The Ruskin Nature Reader." Intermediate Book. Selected and edited by G. R. Bennett. Pp. x+180. (London: J. M. Dent and Co., n.d.) Price 1*s*. 6*d*.

which have long figured in school "readers," and the others, though less familiar in this *rôle*, are none the less fitted for it. The book is nicely illustrated, and concludes with a short glossary of the rarer words and phrases found in the extracts. It may be recommended for class purposes.

THE BOSTON MEETING OF THE AMERICAN ASSOCIATION.

THE sixty-first meeting of the American Association for the Advancement of Science and of its affiliated societies was held in Boston, Mass., December 27, 1909, to January 1, 1910, under the presidency of Dr. David Starr Jordan, of Leland-Stanford University, California. The meeting was a large one, nearly 1100 members of the association being registered, and the total number of men and women of science in attendance was not far from 2000. The number of affiliated societies was larger than usual, numbering thirty in all. The meetings were held in the buildings of the Massachusetts Institute of Technology, in certain of the buildings of Harvard University, Cambridge, and the new Harvard Medical School in Boston. These three groups of buildings are rather widely separated, and for this reason it was difficult to bring together the exact registration.

The opening session was held in Huntington Hall, Massachusetts Institute of Technology, on Monday morning, December 27. Addresses of welcome were given by President McLaurin, of the Institute of Technology, and by Dean W. C. Sabine, of the Graduate Scientific School of Harvard, representing the president of Harvard University. On Monday night the address of the retiring president, Prof. T. C. Chamberlin, of the University of Chicago, was delivered in Sanders Theatre, Harvard University. His subject was a geologic forecast of the future opportunities of our race. The address was preceded by an address of welcome at Harvard University by Prof. F. W. Putnam, a past-president of the association, and who, from 1873 to 1898, was its permanent secretary. After the address a reception was held by the corporation of Harvard University in Memorial Hall. During the week the addresses of the vice-presidents (or chairmen) of the sections were given on the different afternoons as follows:—

Vice-President Keyser, before the Section of Mathematics and Astronomy, the thesis of modern logistic; Vice-President Guthe, before the Section of Physics, some reforms needed in the teaching of physics; Vice-President Kahlenberg, before the Section of Chemistry, the past and future of the study of solutions; Vice-President Swain, before the Section of Mechanical Science and Engineering, the profession of engineering and its relation to the American Association for the Advancement of Science; Vice-President Willis, before the Section of Geology and Geography, the principles of paleogeography; Vice-President Herrick, before the Section of Zoology, evolution of intelligence and its organs; Vice-President Richards, before the Section of Botany, the nature of response to chemical stimulation; Vice-President Woodworth, before the Section of Anthropology and Psychology, racial differences in mental traits; Vice-President Holt, before the Section of Social and Economic Science, the gold question; Vice-President Howell, before the Section of Physiology and Experimental Medicine, chemical regulation in the animal body by means of activators, kinases, and hormones; Vice-President Dewey, before the Section of Education, science as a method of thinking and science as information in education.

The meeting was marked by a series of joint meetings between sections of the association and corresponding affiliated societies. By virtue of a resolution adopted by the council at its April meeting, sectional committees arranged in almost every case one or more sessions of general interest, conducted under the auspices of the sectional officers, while programmes of papers of a strictly technical character and of interest limited to specialists were read under the auspices of the affiliated societies. This arrangement was particularly happy in the cases of Section A and the American Mathematical Society; Section B and the American Physical Society; Section C and the American Chemical Society; Section E and the Geological Society of America; Section F and the American Society of Zoologists; Section G and the Botanical Society of America; and Section H and the American Anthropological Association. Under Section K an important symposium on the subject of internal secretion was held, at which the following papers were presented:—A general review of the chemical aspect of internal secretion, by R. H. Chittenden; the internal secretion of the pancreas, by W. G. McCallum; our present knowledge of the thyroid function, by S. P. Beebe; metabolism after parathyroidectomy, by J. V. Cook; and physiological consequences of total and of partial hypophysectomy, by H. Cushing.

On Tuesday evening, December 28, a public lecture complimentary to the citizens of Boston was given by Dr. C. W. Stiles, of the United States Public Health and Marine Hospital Service, on the subject of the hookworm problem in the United States in reference to public health. This lecture, the subject of which is brought prominently into the public eye at this time on account of Mr. Rockefeller's gift of 1,000,000 dollars to be devoted to an effort to stamp out the hookworm in the south, was attended by a large audience.

On Thursday evening, December 30, an interesting lecture was given by Dr. John B. Smith, on the subject of insects and entomologists, their relation to the community at large.

On Wednesday evening, December 29, the Society of American Naturalists and the biologists in attendance at the meeting held their annual dinner, at which the address of the retiring president of the naturalists, Prof. T. H. Morgan, was given. His subject was "Chance or Purpose in the Evolution of Adaptation." The American Chemical Society gave its annual dinner on the Thursday evening. Other dinners of special organisations were scattered through the week.

At the meeting of the general committee, Minneapolis was chosen as the place of the next meeting, beginning December 27, 1910. The following officers were elected:—

President:—Prof. A. A. Michelson, University of Chicago. Vice-Presidents (or presidents of sections):—Section A, Prof. E. H. Moore, University of Chicago; Section B, Dr. E. B. Rosa, Bureau of Standards, Washington; Section C, Prof. G. B. Frankforter, University of Minnesota; Section D, Prof. A. L. Rotch, Blue Hill Observatory, Boston, Mass.; Section E, Dr. J. M. Clarke, State Geologist, Albany, N.Y.; Section F, Prof. J. Reighard, University of Michigan; Section G, Prof. R. A. Harper, University of Wisconsin; Section H, Prof. R. B. Dixon, Harvard University; Section I, Dr. T. E. Burton, Cleveland, Ohio; Section K, Prof. F. G. Novy, University of Michigan; Section L, the Hon. A. Ross Hill, president, University of Missouri. Secretary, Section I., Fred C. Croxton, Washington, D.C.; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D.C.; general secretary, Prof. F. E. Clements, University of Minnesota; secretary of the council, Prof. J. Zeleny, University of Minnesota.

Grants were made to the Concilium Bibliographicum Zoologicum at Zürich, and to individuals as follows:—To Prof. T. D. A. Cockerell, to assist in an investigation of the microscopic structure of the scales of different genera of fishes; to Dr. W. D. Hoyt, to assist in an investigation upon environic relations of the alga Dictyota, which develops a rhythm in fruiting coincident with every alternate springtide; to Prof. G. J. Peirce, to assist in investigations of organisms inhabiting the alternately filling and drying salt-water pools along the coasts of central California. The last two grants are to be expended under the supervision of the standing committee upon the relation of plants to climate.

THE MEAN HEIGHT OF THE ANTARCTIC CONTINENT.

PROF. W. MEINARDUS gives the results of an estimate of the mean elevation of the central core of the Antarctic land mass, based on the distribution of atmospheric pressure and consequent exchange of air between the two hemispheres, in the November and December numbers of Petermann's *Mitteilungen*. Extending Spitaler's results with the help of Mohn's discussion of the *Fram* observations, and Baschin's maps of the southern oceans, Prof. Meinardus finds that, while the mean pressure (not reduced to sea-level) is 0·85 mm. higher in January than in July between latitudes 0° to 80° N., in the zone 0° to 50° S. it is 2·14 mm. lower. In higher southern latitudes, as far as 60° S. lat., the January pressure is 0·73 mm. less than the July, and from 60° S. to the Antarctic circle the relation is almost one of equality. Hence, allowing for proportional areas, it follows that within the Antarctic circle the true atmospheric pressure must be 11 mm. higher in January than in July.

Observation, however, has so far failed to reveal the existence of this excess; the diminution of the southward temperature gradient and consequent weakening of easterly winds on the edge of Antarctis in summer render it probable that, as in the north polar region, the pressure at sea-level is actually lower in summer than in winter. The discrepancy can be explained by assuming a mean elevation for the area within the Antarctic circle, and taking $-3°$ and $-26°$ as the mean temperatures for January and July respectively, Porf. Meinardus gets a value for this of 1328 metres, or, as a second approximation with temperatures $-6°$ and $-29°$, 1350 metres, with a probable error of $\pm$ 150 metres. Having regard to the proportion of the area known to be covered by sea, the land surface is taken as 14 millions of square kilometres (Bruce and Krümmel), and its mean height then becomes 2000 metres, with a probable error of $\pm$200 metres.

Recent explorations suggest that this value is not far from the truth, the covering of inland ice being, as in Greenland, an important factor. If it is approximately correct, Antarctica is the largest mass of raised land in the world; it is half as large again as Europe, and Asia, the highest of the known continents, has a mean elevation of less than half (950 metres). The accepted value of the mean height of the land surface of the world, 700 metres, is raised to 825 metres, and the mean level of the physical surface of the globe from 205 to 240 metres.

THE NATURAL HISTORY MUSEUM.

IN NATURE of December 16 and 30 we reprinted from the *Times* some letters dealing with this subject. We were under the impression that the main point of contention was the complete separation of the Natural History Museum from the other collections in the British Museum, as recommended by the Duke of Devonshire's Royal Commission in 1874, to go no further back.

Sir Archibald Geikie has since pointed out to us that the questions put to him in the letter from the Speaker of the House of Commons to which he replied "were entirely in reference to the relations between the Trustees and the Museum," and that, this being so, we should have given a letter from Mr. Carruthers dealing with this point which had also appeared in the *Times*. We therefore now reprint the letter in question:—

Sir,—The President of the Royal Society, Sir Archibald Geikie, has expressed clearly his view on the questions in relation to the administration of the British Museum recently raised in your columns. A former eminent President, Prof. Huxley, was brought by his experience as Trustee, as Sir Archibald has been, to similar favourable conclusions.

It was notorious that Prof. Huxley severely criticised the governing body of the Natural History Departments of the British Museum. He had expressed this view to me personally, but, after he had been some time a Trustee, he spontaneously informed me that he had totally changed his opinion, and that he could not imagine a more efficient system of administration. This, I must add, was previous to 1898.

As Keeper of Botany for twenty-four years, I cannot recall a single occasion in which my department suffered from the action of the Trustees. I always found them intelligent and sympathetic in the affairs of the department.

WILLIAM CARRUTHERS.

NOTES.

THE council of the Royal Astronomical Society has awarded the gold medal of the society to Prof. F. Küstner, director of the University Observatory of Bonn, for his catalogue of stars, his pioneer determination of the aberration constant from motions in the line of sight, and his detection of the variation of latitude.

THE Geological Society of London will this year award its medals and funds as follows:—Wollaston medal, to Prof. W. B. Scott; Murchison medal, to Prof. A. P. Coleman; Lyell medal, to Dr. A. Vaughan; Wollaston fund, to Mr. E. B. Bailey; Murchison fund, to Mr. J. W. Stather; Lyell fund, to Mr. F. R. Cowper Reed and Dr. R. Broom.

PROF. R. MELDOLA, F.R.S., has been elected an honorary member of the Sociedad Española de Fisica y Quimica.

PROF. W. TRABERT has been appointed director of the k.k. Zentralanstalt für Meteorologie und Geodynamik at Vienna.

M. G. EIFFEL has been elected president of the Meteorological Society of France for 1910, and M. Teisserenc de Bort and Dr. de Valcourt vice-presidents.

THE death is announced, at the age of ninety-one years, of Dr. George Skene Keith, formerly a well-known Edinburgh physician. Dr. Keith was the author of the book "Plea for a Simpler Life," which had a wide circulation, and of other works.

BY the will of the late Sir Alfred Jones, the sum of about 500,000*l*. will be at the disposal of the trustees "for such charitable purposes and objects in England (or any British possession on the west coast of Africa) as they may in their absolute discretion think fit." For the guidance of the trustees in the administration of this very comprehensive trust, Sir Alfred Jones made the following suggestions, among others, as to purposes to which it might be applied:—(*a*) the technical education of natives on the west coast of Africa; (*b*) the advancement, benefit, or support of education or science; (*c*) original research of all kinds into the cause of disease on the west coast of Africa.

SIR ERNEST SHACKLETON has denied the rumour, to which reference was made in a note last week, that he is to lead this year a third expedition to the Antarctic. He discussed Antarctic exploration recently with a private party of geographical experts in Berlin, and on that occasion explained that, in the event of his going south again, he would travel polewards from the Weddell Sea or Gaussberg. The Weddell Sea was penetrated to 74° 15′ S. by Captain Weddell in 1823. The Gaussberg is a basalt mountain in Kaiser Wilhelm's Land, on the southern shore of the bay in which the *Gauss*, the vessel of the German Antarctic Expedition of 1901–3, reached its farthest south. Captain Scott proposes to establish his base near MacMurdo Sound, which was the winter quarters of the *Discovery*, and near which Sir Ernest Shackleton had his main base during the late expedition.

WE learn from a note in the *Engineer* for January 7 that dirigible airship companies are moving fast in Germany. A Parseval airship was ordered this month by the Munich Aëronautical Company, the share capital of which is to be increased to 400,000 marks. The airship is expected to be delivered on May 1, when regular aërial tours are to be commenced. An airship station is to be built in the Upper Bavarian tourists' territory, to which flights will be made from Munich. Another aëronautical company has been founded this month for exploiting the motor-driven airships according to the system of Herr Zorn, and for establishing airship lines. The municipality of Gräfrath has placed about sixty-eight acres of ground at the disposal of this company. Major Von Parseval has accepted a nomination as unsalaried lecturer on dirigible airships at the Charlottenburg High School, and has already given one lecture before the teaching staff.

THE next International Congress of Mining, Metallurgy, Applied Mechanics, and Practical Geology will be held at Düsseldorf in the last week of June next. The conference will be divided into four sections, dealing respectively with the subjects named in the title of the congress. The president of the mining section is Mr. Randebrock, director-general of the Gelsenkirchener Mining Company; of the metallurgical section, Mr. Springorum, director-general of the Hoesch Iron and Steel Works; of the applied mechanics section, Mr. C. Kiesselbach; and of the practical geology section, Mr. Schulz-Briesen. The general secretaries are Dr. Schrödter and Mr. Loewenstein. There will be two grades of membership of the congress: members, who are entitled to become patrons of the congress by payment of not less than 5*l*., and members who pay a subscription of 1*l*. Any inquiries should be addressed to the committee of organisation of the congress, Jacobistrasse 3/5, Düsseldorf, Germany. Members of the Iron and Steel Institute resident in the United Kingdom who wish to attend the congress are requested to apply to the institute not later than February 26.

DURING last week the Liverpool Geological Society celebrated the jubilee of its first meeting. On Monday, January 10, the society entertained at dinner the Lord Mayor and Lady Mayoress, and representatives of the University, of kindred societies in the city, and of the Yorkshire Geological Society and the North Staffordshire Field Club. The toast of the University elicited expressions of regret at the absence of a chair of geology in the University. The first meeting of the society having been held on January 11, 1860, an open meeting was held on the Tuesday of last week, and was largely attended. Mr. W. Hewitt, the president, was in the chair, and the minutes of the first meeting having been read, he remarked that that meeting was held in a room in the house of Mr. G. H. Morton, the first honorary secretary of the society. He also read a letter from Mr. H. Duckworth, the first president, congratulating the society and regretting that his age prevented his being present. Prof. J. W. Judd, C.B., F.R.S., an honorary member of the society, then delivered an address on "The Triumph of Evolution: a Retrospect of Fifty Years," remarking that the foundation of the society was nearly coincident with the appearance of Darwin's "Origin of Species." A very careful *résumé* of the address appeared in the Liverpool papers, and it is to be hoped that the address will later be printed *in extenso*.

THE first and second annual reports presented by the council of the National Museum of Wales to the Court of Governors are now available. The second report deals with the year ending September 30 last, and records satisfactory progress in the work of founding and establishing the museum. The report points out that Dr. W. E. Hoyle, the director of the museum, entered upon his official duties on March 1. In August an advertisement was issued requesting designs to be sent in for a building to cost 250,000*l*. when complete, and it is hoped it may be found possible to erect about one-third of it in the first instance. The sum of 2000*l*. is included in the estimates of the Chancellor of the Exchequer for the current financial year to defray the working expenses of the museum, and of this 500*l*. has been received. The trustees of the "Cardiff Fund" have handed over the sum of 26,796*l*. which had been collected as a contribution to the building fund in the event of the museum being located in Cardiff. A Bill, promoted by the Cardiff Corporation, is before Parliament empowering the Corporation to make over to the National Museum the collections contained in the Welsh Museum of Natural History, Arts and Antiquities, belonging to the municipality, together with the proceeds of a halfpenny rate, which at the present time would yield about 2000*l*. per annum, towards the maintenance of the museum. In March last the director of the museum visited northern Germany and Scandinavia to study museums and kindred institutions with the view of acquiring information which will be needed in organising the new institution, and a report on the visit is printed as an addendum.

THE *Journal of Conchology* for January contains a paper, by Mr. J. W. Vaughan, on the land and fresh-water molluscs of South Wales.

THE *Entomologist's Monthly Magazine* for January opens with a coloured plate of seven rare or otherwise interesting British insects, of which one is a wasp, while the remaining six are beetles. The wasp, *Odynerus herricki*, was first recorded as British on the evidence of a single specimen in Dorsetshire in 1878; a second example was subsequently taken in Purbeck, and a third near Wareham, but in 1908 the species was found in abundance near Swanage.

IN the report of the Madras Government Museum for 1908–9 it is announced that, at the time when the document was drafted, four volumes of Mr. Edgar Thurston's encyclopædic work on the "Castes and Tribes of Southern India" were then ready, and that it was hoped the printing of the remaining volumes would be completed during the current financial year. The museum has received a number of additions during the year, among which may be mentioned a series of coins acquired by means of the Indian Treasure Trove Act.

THE value of the stereoscope in biological investigations forms the subject of an article, by Dr. W. Berndt, in *Naturwissenschaftliche Wochenschrift* of January 2. The instrument, it appears, has lately been used by Prof. F. E. Schulze, of the Berlin Zoological Institute, for the investigation of the structure and mode of action of the ultimate ramifications of the bronchial tubes, or broncheoli, in the lungs of mammals. Such objects have to be prepared in a special manner before being photographed for the stereoscope, but when this is done a stereogram is stated to afford an insight into the structure which cannot be obtained in any other way. Stereograms of an amœba, of the broncheoli of a rat's lung, and of a section of the lung of an ostrich illustrate the paper.

WE are indebted to the author, Mr. J. W. Shoebotham, for a copy of his paper on the life-history of *Callidium violaceum*, reprinted from vol. iv., part iv., of the *Journal of Economic Biology*. In the year 1908 Mr. Shoebotham noticed insect-borings in some of the wooden fences near Berkhamsted, and subsequently ascertained that these were made by the larvæ of the beetle *Callidium violaceum*, a species which does not appear to have been observed in England as damaging timber since the time of the Rev. William Kirby. Mr. Shoebotham has worked out the life-history of this beetle, which attacks only coniferous timber—more especially larch—from which the bark has not been removed. The larvæ burrow between the bark and the wood, but subsequently tunnel into the latter, in which they pass the pupa-stage.

IN the January number of Witherby's *British Birds* further notes are given with regard to the flights of crossbills which visited the British Islands in the second half of 1909. In Durham these birds were noticed in the last week of June, while at Woburn Abbey a flock was observed so late as December 24. As an appendix to these notes, Dr. C. B. Ticehurst refers to the circumstance that the crossing of the two halves of the beak in these birds is dimorphic, the upper half having its tip directed in some cases to the right and in others to the left side. In *Loxia curvirostra* the rights seem to be about equal in number to the lefts, but in *L. leucoptera* the lefts appear to be twice as numerous as the rights. Further specimens are, however, required before the existence of such a difference between the two species can be considered proven. In 1903 three examples of the black-winged pratincole (*Glareola melanoptera*) were shot in Kent, these being the first recorded British examples of the species. A fourth specimen was shot at Northallerton, Yorkshire, on August 17, 1909.

A DESCRIPTION of the lateral roots of *Amyelon radicans*, a Carboniferous type now accepted as part of a gymnospermous Cordaitean structure, forms the subject of a paper, by Mr. T. G. B. Osborn, in the *Annals of Botany* (vol. xxiii., No. 92) with respect to the branching of the root and the occurrence of a fungus permeating the cells of the cortex. The fungus mycelium is traceable in the outer cortex, but only forms dense tufts in the inner zone; the hyphæ are non-septate, ending sometimes in thick-walled vesicles. Proceeding from analogy with the root-tubercles of Podocarpus, and having regard to the branching tendency of the lateral roots, the author arrives at the conclusion that the fungus was a mycorrhiza.

THE Government of India has issued two additional Forest Pamphlets (Nos. 10 and 11) dealing with Indian timbers, prepared by Mr. R. S. Troup, the Imperial forest economist. The first refers to *Lagerstroemia tomentosa*, a tree, yielding Burmese Leza wood, that grows in the forests of Burma with *Xylia dolabriformis*. It might be classed with American birch, with which, however, it could not compete on the European market. It is recommended for use in India for tea-boxes, and is under trial for railway sleepers, as also for conversion into match splints. The second pamphlet deals with *Carallia integerrima*, which yields a timber resembling European oak in the silver grain, but differing in its brittle nature. Locally it is used in construction and for agricultural implements, and has been favourably reported on for brush-backs.

A PAPER on the British pansies, contributed by Dr. E. Drabble to the Journal of the Royal Horticultural Society (vol. xxxv., part ii.), is brought to notice, not only for the observations which are recorded, but also because it represents a line of work which is desirable and likely to be fruitful in results, especially in the case of plants which are hybridised. The author has taken the species *Viola tricolor*, L., and traced out by comparison with authentic specimens, as also by growing plants through several generations, a series of forms—the elementary species of Jordan and Boreau—among British plants. As a conclusion, four classes of British pansies are demarcated, and it is suggested that the garden stock may have been produced from *Viola Lloydii*, *V. variata*, and (rather doubtfully) *V. polychroma* by crossing with *V. lutea*.

WHEN consideration is given to the great difference between the conditions in the Alps and in English gardens, it is a matter for surprise that so many Alpine plants can be grown successfully in our climate. The contrast is well brought out in an article published in the Journal of the Royal Horticultural Society (vol. xxxv., part ii.) by Mr. A. Clutton-Brock, who submits some arguments with respect to cultivation and treatment which cannot fail to interest the growers of alpines. Primarily, the author directs attention to the correct disposition of rocks and stones so that the roots may run underneath and obtain protection from drought. This is particularly necessary for Dryas, *Silene acaulis*, and *Polygala Chamaebaxas*. Top-dressing is suggested for Primula and *Aster alpinus* to imitate the action of deposits left by the snow. Close planting is another recommendation, provided unequal competition between intermingling plants can be avoided. On this point the author gives details regarding suitable combinations of plants.

FROM the *Agricultural Journal of British East Africa* we learn that cotton growing is making steady and continuous progress at the coast, although the early difficulties were very numerous, and large sums of money had to be expended in educational work. There is still the prospect of trouble with insect pests, but it is stated that cotton growing is distinctly profitable to the native. In the same journal there is also a suggestive article on the prospects of the production of cane sugar; considerable quantities are at present imported, but there is every reason to believe that it could be produced locally and form the basis of a flourishing industry.

WE have received from the United States Department of Agriculture Bureau of Soils a bulletin, by Dr. Whitney, summarising the results of nearly 3000 manurial trials on cotton soils made during the past twenty-one years. The general conclusion is that complete fertilisers give the largest and, as a rule, the most profitable crop. The increase in yield due to mixtures of artificial manures was approximately an additive effect, an interesting result that deserves further examination. A report is also issued on the Volusia soils, which cover an area of more than ten million acres in southern New York, northern Pennsylvania, and north-eastern Ohio, and are commonly said to be "worn out," the farms in some localities having been abandoned. It is well illustrated and typical of the soil survey work carried out by the department. The soils suffer from lack of drainage, poor physical condition, and depletion of organic matter, conditions for which suitable remedies are suggested.

WE have received advance chapters of the annual report on the mineral production of Canada during the calendar years 1907 and 1908, dealing respectively with the production of coal, coke and peat, of natural gas and petroleum, and of iron and steel in the Dominion. These reports show a steady but not a great development in all these branches of mineral industry; the production of coal in the two years in question was respectively 10,511,426 and 10,886,311 tons, as against 9,762,601 tons in 1906, about one-eighth of this being made into coke; the production of peat was practically nil. The production of crude petroleum was 788,872 barrels (of 35 gallons) in 1907 and 527,987 barrels in 1908; the production of natural gas was also important. The production of pig iron is about stationary, being 651,962 tons in 1907 and 630,835 tons in 1908, about one-sixth in each case being smelted from native and the remainder from imported ores.

MR. R. A. STEWART MACALISTER, by permission of the committee of the Palestine Exploration Fund, for whom the materials were originally collected, contributes to the number of the Journal of the Gypsy-lore Society for October, 1909, the first of a series of papers on the language of the Nawar or Zutt, the nomad smiths of Palestine. The language is in its basis pure Romani, but it has assimilated many Arabic words, that is to say, not literary Arabic, but the colloquial dialect of Palestine. Some words are used without change, but a large number have become naturalised in Nuri, either indicating that they are survivals of a period when the tribe had newly arrived in Arabic-speaking lands, or that some terms have been modified with the object of secrecy to adapt them for use in the tribal argot. Mr. Macalister works out carefully the method of making these modifications. It is to be regretted that few of the stories so far published include any interesting or characteristic folk-lore material, most of the examples being incidents of everyday life or scraps of folk-tales dictated by the compiler.

AN excellent general account, by Dr. H. R. Mill, of the rainfall of the British Isles in 1909, in relation to other years, is contained in the *Times* of January 14, based upon a preliminary study of some 2000 of the returns of the British Rainfall Organisation, and on a comparison of 100 long-established records, distributed as uniformly as possible over the country, with their own averages for 1870–99. These latter values are given in tabular form, and the summary of the percentages shows considerable differences in various divisions; in Scotland, as a whole, the annual rainfall was practically normal; in Ireland and Wales there was a deficiency of 5 per cent., in the north of England a considerable excess, while the amount over the British Isles generally was exactly the average. These results naturally agree in the main with those given by the Meteorological Office in its annual summary (NATURE, January 6). The best idea of the difference of the annual rainfall of the year from the average is shown by a neat little map. This exhibits conspicuous dry areas in the extreme south-west of Ireland, Wales, and England, and in the north-west of Scotland. The distinctly wet regions, with more than 10 per cent. above the average, surround the south and east of Great Britain; another area with more than 10 per cent. was in Lincoln, the north-east of Yorkshire, and Lancashire. The wettest months, generally speaking, were March, April, October, and December. November was unquestionably the driest month; over the whole of England the rainfall was only one-third of the normal. Dr. Mill remarks that the year probably acquired its undeserved reputation for wetness from the chilly gloom of some of the summer months, which both looked and felt far wetter than they were.

MESSRS. TEUBNER are issuing in pamphlet form some of the most important of the public addresses which have been delivered by distinguished German physicists during the last few years. Amongst them is one on electrons, given by Prof. W. Wien before the Versammlung deutscher Naturforscher, which has already reached a second edition. It deals in a clear and interesting way with the rise and progress of our knowledge of the properties of electrons, and explains the methods by means of which that knowledge has been acquired, without making a great demand on the reader's mathematical powers. Prof. Wien prefers the theory which makes an electron in motion take a spheroidal shape to that on which electrons are rigid spheres, and shows in his additions to the present edition that the evidence from the principle of relativity supports this view. A special difficulty of the electron theory is, in his opinion, that of explaining how an electron holds together under the enormous repulsive forces which the parts of it exert on each other.

THE *Journal de Physique* for December, 1909, contains a paper communicated to the Société française de Physique on November 19 by M. L. Houllevigue, in which the sizes of the particles shot off from a silver kathode in a vacuum tube are calculated. The method depends on the fact that when a vapour condenses on a surface colder than itself the drops form at definite points of the surface constant in number, and if evaporated and re-condensed form again at the same points. When a glass surface has been exposed to bombardment from the kathode rays, the author considers that the points at which condensation of a vapour occurs are those at which particles of the kathode have become attached to the glass. The number of these points, and therefore of the kathode particles, is proportional to the time of exposure to the bombardment, and may be counted directly under the microscope after mercury vapour has condensed on them. The thickness of a deposit may then be found by Fizeau's method after the film has been exposed to the vapour of iodine. From the volume of the deposit on any area and the number of particles calculated from the counting experiment, M. Houllevigue finds the volume of the particle shot off from a silver kathode to be about 7×10^{-13} cubic millimetres, that is, it consists of about 20 million molecules.

FOR several years the Scottish Provident Institution, Edinburgh, has issued, within the covers of a blotter, an excellent set of star-maps, by Mr. W. B. Blaikie, showing the constellations visible when facing north and south month by month. The stars are represented by gilt asterisks on a dark blue background, upon which the names of the constellations are printed in black, so that when the charts are viewed at a suitable angle the stars are seen without the names, the result being very effective. With the 1910 issue (the thirteenth series), a chart of the heavens in two hemispheres is included showing the track of Halley's comet in 1909–10, and some notes upon the comet's orbit and spectacular appearance. The usual particulars of the positions of the sun, moon, and planets throughout the year are also given. The publication is excellently produced, and should continue its usefulness in promoting an intelligent interest in the aspects of the heavens and the movements of celestial bodies.

A VALUABLE paper on the testing of impulse water-wheels of the Pelton wheel type was presented by Mr. William Rankine Eckart at the Institution of Mechanical Engineers on January 7. This paper is of interest on account of the experiments described being the first of the kind on such a large scale. By means of the Pitot tube and other measuring devices the author has measured the nozzle discharge under different conditions, and so has determined the hydraulic efficiency of the generating plant, the capacity of each water-wheel amounting to about 3500 horse-power. The following table gives a summary of the more important results of the four tests made, and shows the distribution of the power as percentages of the power in the jet:—

Test number	1	2	3	4
Loss in bucket friction and eddies ...	23·0	23·2	27·7	29·2
Loss in residual velocity of discharge..	1·1	1·0	1·8	1·9
Other hydraulic losses	1·5	1·6	1·1	0·8
Loss in friction and windage, generator and wheels	7·5	4·4	3·2	2·8
Loss in generator, iron and armature..	2·8	1·8	1·3	1·2
Delivered to switchboard	64·1	68·0	64·9	64·1

IN the discussion on the hydraulic papers at the Institution of Mechanical Engineers on January 7, Dr. Unwin referred to the difficulties which Canadian engineers have to contend with in preventing stoppages from ice. Block ice is easily dealt with. With frazil ice, *i.e.* minute particles of ice suspended in and moving with the water, the difficulty is serious. We learn from a recent number of the *Canadian Engineer* that about forty water-wheels at and near Ottawa are now equipped with heating devices, which prevent frazil from stopping the wheels and clogging the gates and gate-mechanisms. The latest 3000-horse-power unit at the Ottawa and Hull Power and Manufacturing Company's Station has the chutes and gate chambers cored out, and there are pipe connections to the openings so that steam or hot water may be kept circulating through them when frazil is anticipated. The racks or screens are kept free from ice by electric motor-driven rakes, and at present none of these is heated. Mr. John Murphy recommends that the racks be submerged or otherwise protected from the atmosphere, when only a small amount of heat would be necessary to prevent ice clinging to them.

COMMENTING on the evidence offered at the inquiry into the cause of the disastrous fire at Messrs. Arding and Hobbs, Clapham Junction, the *Builder* for January 8 finds itself unable to agree with the architect's—Mr. Thorneycroft—opinions regarding his belief in the merits of steel as a structural material. Evidently he does not consider reinforced concrete to be a practical substitute for steel. It is, of course, understood that there are difficulties in altering and enlarging old buildings which prevent the changing of the general nature of the construction. Other evidence showed that, had there been concrete floors, and if the steel-work had been encased in concrete, there would have been little to burn except the contents of the rooms. As it was, the girders were only protected by the matched lining, and the distortion of the steel brought the building down. However strongly one may disapprove such methods of construction, the fact remains that the Clapham Junction building conformed with the requirements of the law, and represented quite an ordinary risk. Under the new regulations of the County Council protected steel-frame or reinforced concrete buildings ought to cost no more than structures of brick and unprotected steel. The extreme undesirability of the latter type is the most important lesson of this fire.

ON account of its fundamental importance in atomic-weight determinations, numerous researches have been published during the last four years on the atomic weight of chlorine, in most of which the direct ratio H/Cl has been attempted by gas volumetric or gas density methods. The latest contribution to this subject is by Otto Scheuer, who, in the current number of the *Zeitschrift für physikalische Chemie*, finds the weight of a litre of hydrochloric acid to be 1·6394 under normal conditions. From this the figure 35·466 is deduced as the atomic weight of chlorine, differing from the 35·460 of Gray and Burt by about 1 part in 6000. The paper in the *Zeitschrift* gives full details of the experimental work, and also of the methods of reduction employed. A critical examination of the results of Gray and Burt is given at the end of the paper.

THE place of honour in the *Bulletin de la Société d'Encouragement pour l'Industrie nationale* for November, 1909, is given to a study, by MM. Pipereaut and Vila, on the manufacture of zinc sulphide and its use as a pigment. From a report by M. A. Livache, which precedes the memoir, it appears that a law has just been passed prohibiting entirely the use of white lead as a paint after the expiry of a period of five years, and that the authors have devised a satisfactory method of preparing zinc sulphide, as a substitute, by dissolving the oxide in caustic alkali and boiling the solution with sulphur, the first portion of which throws down the impurities (lead and other metals giving coloured sulphides), whilst the later additions precipitate the zinc sulphide in a pure form which (after drying at a red heat) is eminently suited for use as a paint.

THE monographs on photo-chemistry by Prof. Bancroft, which have been appearing in recent numbers of the *Journal of Physical Chemistry*, have been followed up by two experimental papers, one of which, by Mr. G. A. Perley, on solarisation, appears in the November number, and the other, by Mr. J. W. Wilkinson, on the phosphorescence of some inorganic salts, in the December number of 1909. The latter contains an interesting account of some luminous effects produced during the electrolytic preparation of insoluble metallic salts, and during slow oxidation, chlorination, &c. In a large range of cases it is shown that the colour of the light emitted is identical with that which is produced when the salt is made to phosphoresce by various methods, and the view is advanced that the phosphorescence is due to certain definite types of chemical change.

THE *Journal of Physical Chemistry* for November, 1909, contains a paper, by Mr. B. E. Curry, on the alloys of zinc with antimony, tin, cadmium, bismuth, and lead. Although the metal forms two layers with lead and with bismuth at low temperatures, the mutual solubility increases rapidly as the temperature is raised, the lead-zinc alloys becoming completely homogeneous at about 920° and the bismuth-zinc alloys at 820°. The formation of compounds was observed only in the alloys of zinc and antimony, which gave crystals of ZnSb and Zn_3Sb_2, but solid solutions were obtained of zinc in tin (up to 7 per cent. Zn), in bismuth (up to 4 per cent. Zn), and in cadmium (up to 4 per cent. Zn), and of cadmium in zinc (up to 4 per cent. Cd); the zinc-antimony alloys also gave three series of solid solutions, resulting in a very complex equilibrium diagram.

THE Journal of the College of Science, Tokyo, of June 15, 1909, which has recently come to hand, contains a paper, by Y. Shibata, on the action of the Grignard reagent on *o*-phthalic esters. The *p*-phthalic esters have been shown by Ullmann and Schaepfer to resemble the succinic esters in giving glycols of the type $C_6H_4\left\langle\begin{matrix}CR_2.OH\\CR_2.OH\end{matrix}\right.$, but the main product from the *o*-esters is a phthalide such as

$$C_6H_4\left\langle\begin{matrix}C(CH_3)_2\\CO\end{matrix}\right\rangle O,\quad C_6H_4\left\langle\begin{matrix}C(C_2H_5)_2\\CO\end{matrix}\right\rangle O \text{ or}$$

$$C_6H_4\left\langle\begin{matrix}C(C_7H_7)_2\\CO\end{matrix}\right\rangle O.$$

The action may, however, proceed further, giving rise to the compounds

$$C_6H_4\left\langle\begin{matrix}C(CH_3)_2\\C(:CH_2)\end{matrix}\right\rangle O \text{ and } C_6H_4\left\langle\begin{matrix}C(CH_2.C_6H_5)_2\\C(:CH.C_6H_5)\end{matrix}\right\rangle O.$$

A remarkable compound of the second group is obtained by the action of phenyl magnesium bromide. It is formulated as $C_6H_4\left\langle\begin{matrix}C(C_6H_5)_2\\C(:C_6H_4)\end{matrix}\right\rangle O$, but must be regarded as containing a trimethylene or "carone" ring in the group $-C{=}C_6H_4$.

MR. P. D. MALLOCH, of Perth, is publishing through Messrs. A. and C. Black a book on the "Life-history and Habits of the Salmon, Sea-trout, Trout, and other Freshwater Fish." From his connection with the Tay Salmon Fisheries Co., the author has had unusual opportunities of studying the subject, and has been able to clear up many doubtful points by the marking of smolts and their recapture as grilse and salmon. The study of scales also forms a section of the book.

M. CH. DELAGRAVE, of Paris, has sent us a copy of "La Langue Internationale et la Science," which is published at the price of one franc. This volume is a French translation of a book reviewed in these columns on August 19 last (vol. lxxxi., p. 218), "Weltsprache und Wissenschaft. Gedanken über die Einführung der internationalen Hilfsprache in die Wissenschaft," by Profs. L. Couturat, O. Jespersen, R. Lorenz, W. Ostwald, and L. Pfaundler. The translation has been done by M. Boubier, of the University of Geneva.

THE issue of Willing's "Press Guide and Advertiser's Directory and Handbook" for 1910 (price 1*s*.) has reached us. It continues to be what its subtitle claims for it—a concise and comprehensive index to the Press of the United Kingdom. It provides information concerning all the newspapers, magazines, reviews, and other periodicals, including journals, proceedings, reports, and transactions of learned societies. Lists of the principal colonial and foreign journals are also included.

THE 1910 issue of "The Science Year Book," edited by Major B. F. S. Baden-Powell, and published by Messrs. King, Sell and Olding, Ltd., at 5*s*. net, includes several new features. The volume contains a monthly astronomical ephemeris which should be of particular service to astronomers and other observers, many useful tables, star-maps for the four seasons, with key-charts showing the names of constellations visible, a brief summary of matters of scientific interest in 1909, a glossary of recently introduced scientific names and terms, a full list of learned societies with particulars of membership, and a short account of various prizes and awards for scientific research. A good portrait of Sir Archibald Geikie, K.C.B., forms a frontispiece to the volume, and there is a chart showing the track of Halley's comet during 1910. The remainder of the volume consists chiefly of a diary, with a page for each day, and having at the head columns for the insertion of maximum and minimum temperatures, barometric height, rainfall, and other results of meteorological observation. The volume provides observers with exactly the kind of tabular information frequently required; and, with the diary, it constitutes a year-book which merits a place upon the study tables of many men of science and the bookshelves of observatories.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A NEW COMET.—Telegrams from the Kiel Centralstelle announce the discovery of a new comet at Johannesburg on January 17. In the first it was stated that the comet was discovered by Mr. Drake, and was seen at and after sunrise. Its approximate position was given as five or ten degrees south-south-west of the sun, which it was approaching.

The second telegram gives the more exact position, at 21h. 21·5 m. January 16 (Johannesburg M.T.), as

$$\text{R.A.} = 19\text{h. } 50\text{m. } 28\text{s.}, \quad \delta = 25° \ 9' \text{ S.},$$

and states that the daily motion is +16m. 32s. in R.A. and −2° 25′ in N.P.D.

As this object is intensely bright as it was seen in sunshine, and is travelling northwards, we may expect a fine display after sunset during the present week.

HALLEY'S COMET.—A telegram from Messrs. Frost and Parkhurst, dated December 31, 1909, and published in No. 4381 of the *Astronomische Nachrichten*, states that the prismatic camera shows the light of Halley's comet to be now largely due to the third cyanogen band. This suggests that attempts to photograph the comet should now be made with quartz objectives or speculum reflectors. Both glass objectives and silver-on-glass mirrors absorb a large percentage of the ultra-violet radiations, and the difficulty of obtaining quartz lenses of large aperture may possibly be compensated for by the much greater transparency of quartz, as compared with glass, to the more refrangible rays.

The anomalous apparent brightening of the comet which occurred in November has not been continued, and until about the middle of March the distance between the comet and the earth will continuously increase; but it is thought that the development of the comet, as it approaches nearer to the sun, should be sufficient to make naked-eye observations possible by about the end of February.

This anomalous increase of the apparent brightness is described by the Rev. T. E. R. Phillips in a note appearing in No. 2, vol. lxx., of the Monthly Notices. He commenced observing, with a 12¼-inch Calver reflector, on November 16, and observed the apparent brightness on ten nights between that date and December 8; from these observations he concludes that the apparent brightness of the comet was unquestionably greatest on November 22, when he was able to see it with the aperture stopped down to 3½ inches. The next night, under comparable atmospheric conditions, it was quite inconspicuous even with the full aperture. Again, on December 6, with a very clear and transparent sky, he was unable to see the comet with the aperture at 4½ inches, and he estimates that its magnitude was not greater than 11·5 or 12·0; but on December 8 it was again brighter, the magnitude being estimated to be about 10·5 or 11·0.

On January 28·1 the comet will be in conjunction with, and 3° 48′ north of, Saturn; its conjunction with Mars occurred on January 15, when the actual distance separating the two bodies, about 37 million miles, was at its minimum value.

In a letter to the *Times* of January 14, the Earl of Crawford points out that for ages the sudden appearance of a great comet has been held to herald some great disaster or revolution. This view of the matter may still appeal to the native races of such countries as Morocco, Egypt, or India, where considerable unrest already prevails, and might be used by fanatical agitators to stir up further trouble. He suggests that the communication of a series of popular articles, written in the vernacular, to the native Press, might be beneficial. By announcing and welcoming the appearance of the comet, such articles would forestall the potential mischief-makers and render futile their possible announcements of supernatural manifestations.

THE SPECTRA OF COMETS' TAILS.—The observations of Deslandres, Evershed, Chrétien and others showed that in the spectra of the tails of Daniel's and Morehouse's comets there were certain radiations which were feeble in the heads but extended to considerable distances in the tails of those comets; the wave-lengths of the three strongest bands were about 402, 426, and 455, but no terrestrial origin could be found for them.

This has now been done by Prof. A. Fowler, who has succeeded in reproducing them terrestrially in the spectrum of the glow from vacuum tubes which were known to contain carbon compounds at extremely low pressures, 0·01 mm. or less. Further experiments are necessary to determine what particular form, or compound, of carbon is involved, but from the wave-lengths and the reproductions of the spectra published in No. 2, vol. lxx., of the Monthly Notices there can be no doubt that Prof. Fowler has succeeded in reproducing, in his laboratory, the conditions which obtained in the tails of the two comets mentioned above.

TWO CURIOUSLY SIMILAR SPECTROSCOPIC BINARIES.—When Messrs. Plaskett and Harper, of the Ottawa Observatory, published the determined orbit of the spectroscopic binary ι Orionis, the apparent presence of a secondary disturbance was not discussed, because the lines of the spectrum are too diffuse to justify any final conclusions; but the recent determination of the orbit of another binary, B.D. − 1°·1004, showed that a similar case of secondary disturbance appeared there, and it was deemed desirable to make refined least-square solutions for both orbits.

The results show that the two binaries are remarkably alike. Both are in Orion, within 5° of each other, and both are helium stars; the periods are 29·136 and 27·160 days respectively, and the eccentricity of both orbits is abnormally high (0·74 and 0·76) for spectroscopic binaries. Other features are also very similar, but the most striking similarity is in the secondary disturbances, which are almost identical in period, amplitude, and phase. The period of the secondary in each case is the same as the period of the primary, a novel feature in spectroscopic binaries. It seems probable that the same physical cause is operative in both cases, but what it is is difficult to say; the orbital revolution of the system, produced possibly by a resisting medium or by tidal action, is tentatively suggested (*Astrophysical Journal*, vol. xxx., No. 5, p. 373).

THE "ANNUAIRE ASTRONOMIQUE," BELGIUM.—The "Annuaire Astronomique," for 1910, of the Royal Observatory of Belgium contains, besides the usual tables, ephemerides, &c., a number of useful notes and diagrams; among the latter is a coloured chart showing the official standard times of various countries. A list of observatories is also given, and special articles are contributed by various members of the staff of Uccle Observatory.

THE EVOLUTION OF THE BRAIN.[1]

AS the result of the investigations carried on in the Museum of the Royal College of Surgeons during the last seventy-five years by its conservators and those who have drawn their inspiration, directly or indirectly, from the work done in the museum, it has become possible to establish on a firm basis the criteria for instituting exact comparisons of the structure of the brain in the various groups of Vertebrata.

This analytical work has now been carried far enough to justify us in attempting a synthesis of our knowledge of the evolution of the cerebral cortex. The special aim of such a research is to investigate the nature of the factors and the circumstances which have brought into being the neopallium, the part of the nervous system which, more than any other, is responsible for the kaleidoscopic manifestations of psychical activities, and the possession of which has made the Mammalia what they are, and given them the dominant position in the animal kingdom.

At the very root of the Vertebrata we find that Petromyzon has a cerebral hemisphere no larger than the olfactory bulb of which it is little more than an appendage. Direct nerve tracts pour smell-impressions into almost every part of the surface of this hemisphere. The cerebrum at its commencement is thus almost purely an instrument for the reception and the conscious appreciation of stimuli evoked by odoriferous particles, and, in the second place, for providing the means whereby the physiological processes underlying this state of consciousness may affect the rest of the nervous system, and through it influence the behaviour of the lamprey itself. It is just possible that even in this lowly vertebrate gustatory fibres brought up to the lobus inferior (of the fore-brain) from the terminal nuclei of the seventh and ninth nerves may make their way into the primitive cerebral hemisphere, but it is still uncertain whether the lobus inferior itself may not be the place where impressions of smell and taste meet.

Even in Petromyzon there is some indication of a differentiation of the hemisphere into a superficial cortical layer (tuberculum olfactorium) and a deeper ganglionic part (corpus striatum), and there is also some slight trace at the extreme dorso-mesial edge of the presence of a small rudiment of the pallium. The tuberculum olfactorium in the Selachii assumes a definite cortex-like arrangement of cells, and is now recognisable as one of the receptive apparatus for olfactory impulses coming directly from the olfactory bulb. The corpus striatum does not receive any direct olfactory fibres; it is the part of the hemisphere which receives afferent fibres from the tuberculum olfactorium, and possibly also from more caudally situated regions of the brain—almost certainly gustatory fibres from the lobus inferior—and it emits efferent fibres, which pass to the hypothalamus and indirectly influence the executive mechanisms of the body, *i.e.* its functions find expression in the behaviour of the animal.

In some of the Selachii the dorsal part of the hemisphere is definitely transformed into a cortical area or formatio pallialis. In Petromyzon there is still room for doubt as to the existence of any such structure, but when we turn to the study of the brain in some of the sharks there can be no doubt of the existence of a considerable area of primordial pallium. There is every reason to believe that this pallial formation represents the undifferentiated rudiment of the *whole* pallium of the higher vertebrates. Its mesial edge ultimately becomes specialised to form the hippocampus, which in the higher Vertebrata does not receive smell-impulses directly from the olfactory bulb, but indirectly through the intermediation of the olfactory peduncle and tuberculum olfactorium on the mesial side, and of the pyriform on the lateral side. The lateral edge of the pallium eventually develops into the pyriform lobe, which continues to receive olfactory impressions direct from the bulb. Much later on, only, in fact, when the mammal appears on the scene, the pallial area intervening between the hippocampus and the pyriform lobe becomes specialised to form the neopallium. It is only right to say that this view of the nature of the primitive pallium differs funda-

[1] Summary of Three "Arris and Gale Lectures" on "Some Problems relating to the Evolution of the Brain," delivered in the Royal College of Surgeons on December 13, 15, and 17, 1909, by Prof. G. Elliot Smith F.R.S.

mentally from the various interpretations now being urged by other biologists.

Putting aside the condition of affairs found in all other Ichthyopsida, the consideration of which would be confusing unless there were time to discuss their morphology in some detail, let us look for a moment at the brain of the Dipnoi. In the mud-fish the cortex-like material forming the tuberculum olfactorium becomes highly specialised, and forms a relatively enormous organ upon the basal aspect of the cerebral hemisphere, of which it constitutes more than half the bulk. The pallial formation also becomes more distinctly differentiated into a cortex, the lateral part of which can now be justly termed "pyriform" and the mesial "hippocampal." The fornix-fibres connected with the latter are embedded in a mass of ganglionic matter—the paraterminal body—which exhibits a functional relationship to the hippocampus analogous to that which the striate body presents to the other cortical areas. In other words, it is a nucleus of origin for large numbers of projection fibres which pass down to the hypothalamic region, and the cells of origin of these fibres are probably under the influence both of descending hippocampal (smell) fibres and ascending tracts from the lobus inferior of the hypothalamus (probably taste).

Leaving the Amphibia out of account, and turning at one step from the Dipnoi directly to the reptiles, it will be found that the highly developed tuberculum olfactorium of the Dipnoi has undergone a great diminution in size and an even more pronounced deterioration in structure, but the corpus striatum and the pallial formation show a great advance both in size and in specialisation of structure.

There are very definite reasons for rejecting the views of Ramon y Cajal as to the homology of the mesial wall of the reptilian hemisphere, and also von Kupffer's identification of the hippocampus. Nor can we accept in its entirety the interpretation of the limits of the hippocampal formation and of its constituent parts favoured by Edinger and Ariëns-Kappers.

The hippocampal formation of the reptile is *not* broken up into two parts, fascia dentata and hippocampus *sensu stricto*, as it is in the mammal, but is a continuous column of cells, as the lecturer pointed out in 1895—an opinion since confirmed by Giuseppe Levi.

But there is no fully differentiated fascia dentata in reptiles as Levi believes. The hippocampal formation of a lizard contains cells analogous to those of the fascia dentata *intermingled with* others like those of the hippocampus *sensu stricto*, and others, again, intermediate in structure between the two. Thus in the reptile the hippocampal formation is caught, as it were, in the act of differentiating. Ultimately (in mammals) all the hippocampal cells vanish from its mesial part, leaving only "dentate" cells, which form a receptive organ for incoming olfactory impulses, and the lateral (dorsal) part of the formation loses all its "dentate" cells and becomes a purely associative and projection-organ.

In reptiles, the larger size of the corpus striatum and pallial formation is probably related to the fact that many sensory fibres ascending from the optic thalamus make their way into the hemisphere. The researches of Edinger, Wallenberg, Gordon Holmes, Ariëns-Kappers and others, have made it appear most likely that these fibres carry tactile impressions from the tongue and the cutaneous areas around the mouth, and possibly also visual impulses.

These two categories of fibres are certainly abundant in the peculiarly aberrant and highly specialised brain of the bird, in which the corpus striatum takes on an enormously enhanced importance and significance, and develops along lines which diverge widely from the stream of mammalian evolution.

In the reptile there is no true neopallium, but great confusion in the relations is produced, because the lateral part of the pallial formation is being suddenly stimulated to expand by the entry of these sensory, and perhaps visual, fibres. The rapidly overgrowing cortex becomes bent into the ventricular cavity to form a pseudo-ganglionic (but really cortical) mass, which Edinger has called Epistriatum.

In the immediate ancestors of mammals the number and variety of sensory paths which found admission into the cerebrum became enormously increased, and led to a further specialisation of the pallial formation, resulting in the birth of the neopallium—a cortical area where all the sensory impulses brought to the cerebral hemisphere along these new channels might be received, be blended in consciousness with those coming from other sense-organs, and leave impressions which might be stored, as it were, in this neopallium, and so influence other sensations and states of consciousness at some subsequent time. The neopallium is thus the organ of associative memory.

It is, perhaps, not devoid of significance that the first appearance of a definite neopallium coincides with the transformation of the skin over the whole surface of the body into a highly specialised tactile organ.

The further evolution of the neopallium in the Mammalia, and the formation of sulci and convolutions, was also discussed, special stress being laid upon the value of the unrivalled collection of brains in the college museum for the study of this aspect of the subject.

CONFERENCES ON SCIENCE AND MATHEMATICS IN SCHOOLS.

THE Mathematical Association and the Public Schools Science Masters joined forces at their annual meetings held this month at Westminster School. We print below a programme of the proceedings, and attempt to indicate the present situation of science and mathematical teaching in relation to the work of these associations, following lines of thought prompted by the expression of opinion at the meetings.

We must first discriminate between the Mathematical Society and the Mathematical Association. The former body is devoted to research, the latter to the improvement of elementary mathematical teaching. The organ of the association is the *Mathematical Gazette*; one hears complaints that disproportionate space is given in its columns to problems of purely mathematical interest or to minutiæ, while the clamant need for reconsidering the bases of one of the fundamental branches of education remains unsatisfied.

In the course of a vigorous presidential address, Prof. Turner spoke of the reign of efficiency established in the department of Egyptian service under Captain Lyons. For responsible work of varied nature Captain Lyons selected able mathematicians from Oxford and Cambridge. These men proved successful, and Prof. Turner directed attention to this fact in support of his opinion that it is a mistake to strive after a "general education" for all boys. A gardener might as well treat his flowers as cabbages. In the paper which followed, Mr. Godfrey emphasised the importance of paying regard to the different requirements of students. The precise value of algebra in education deserved greater consideration. The remaining papers hardly provided such nutrient fare as one would wish for on an occasion when masters and mistresses from schools all over the country are summoned for annual conference. In the afternoon, however, a crowded meeting discussed the urgent problem of how to correlate mathematical and science teaching, an important report serving as the basis of debate. The committee responsible for the report consisted of six representatives of mathematical teaching, six of science, and two head-masters of preparatory schools. They had been asked to consider the possibility of correlating the teaching of mathematics and science, and their reply took the effective form of a series of recommendations for putting such correlation into practice. As might be expected from the composition of the committee, all the recommendations were evidently the outcome of practical experience in the class-room. The prime necessity was cooperation between the teachers of the respective branches, and it was recognised that the chief obstacle was the lack of laboratory training, which was, unfortunately, so common amongst mathematicians. To aid in removing this obstacle, an appendix was devoted to the vacation course in practical work organised for schoolmasters at the Cavendish Laboratory; the course was given last August, and is to be repeated next summer.

Many of the recommendations are commendable, *e.g.* that the practical measurements should have a real connection, not only with the ordinary arithmetical lessons, but also with the actual details of daily life. Nevertheless the general impression conveyed is disappointing. A prefatory memorandum warns the reader that the committee regarded as outside its purview the discussion of the functions of science and mathematics in a balanced education. This estimate of its duties appears to account for the limited view which detracts from some portions of their work. We recognise the right of the committee to formulate opinions directly contravening the principles of Prof. Perry, but it should be made clear that the committee has considered the methods advocated by men of no little experience and judgment with whom it disagrees. Again, there is a half-heartedness in some of the proposals which suggests that the committee has not yet advanced to the position taken by leading writers more than twenty years ago. For example, no reference whatever is made to graphs, and the official dictum of the Mathematical Association still stands "that it is undesirable (at the preparatory stage) to lay stress on the *practical employment* of graphs in solving equations or other problems." [The italics are in the original, *vide* Reports of the Committee of the M.A., p. 29 of the 1908 issue.]

The discussion was preceded by an eloquent benedictory address from Prof. Forsyth. He quoted Faraday's advice to Tyndall to work out any experimental result so far as possible, "so that the mathematicians may be able to take it up." Much good would accrue to the training of schoolboys if scientific results could be so left that mathematicians, even mathematical schoolboys, could "take them up." Prof. Forsyth also quoted from the regulations for the Mathematical Tripos to show that settled thought at Cambridge is in harmony with the spirit which animated the joint committee whose report was before the meeting. He pleaded for patience in early years of growth—"go gently, and you will go safely; go safely, and you will go far." It was plain from the speeches of Mr. Godfrey and Mr. Jackson that the committee had exercised much restraint, and that it had deliberately erred on the side of caution in the changes which were recommended.

Sir J. J. Thomson said exactly what was wanted. He amused the meeting by his description of the student at Cambridge who wanted a kind of physics that would not give a headache to a caterpillar, and of the delight and surprise of the mathematician at finding in the laboratory that the formulæ on which he had been working for many years bore some approximation to truth. He hoped the effect of the report would be to increase the belief of mathematicians in applied mathematics. In schools, mathematics and physics should go together almost from the beginning. It was necessary to make men believe in their mathematics. Was it necessary that mathematical masters should teach so little mathematics?

We have dwelt upon some of the weak points because, in our view, the present condition of mathematical teaching in schools calls loudly for reform, in which the Mathematical Association should take the lead. But it would be utterly unfair and untrue to describe either the report or the meeting as less than a success. Prof. Forsyth paid a well-merited tribute to the committee for the careful inquiries it had instituted and carried to completion, and for the practical character of its proposals. The meeting was crowded, and there was no hint of opposition to the work of correlation. The following resolution was passed without dissent and with heartiness:—"That this meeting is in sympathy with the attempt embodied in the present report to correlate more closely the teaching of mathematics and science."

The principal feature of the Science Masters' meeting was the president's address, entitled "The Future of Science in our Schools—their Complete Re-organisation a Necessity." Prof. Armstrong said that the men most competent to take charge of the schools in the future would be the science masters, it being their business to study method and to be practical, therefore to solve problems and to lead. Referring to compulsory Greek, he declared that Oxford insists upon lowering the moral tone of entrants upon university life by enforcing a test which is known to be farcical and futile, known to be one which spoils young lives in preparatory schools; and doctors of divinity in charge of our schools smile blandly at such proceedings.

The teaching of science in our schools should consist primarily of instruction in the art of inquiry. Our failure to make science teaching effective is due to a misunderstanding of what an experiment is. To speak of *showing* an experiment is a negation of terms—actually, a demonstration is given. Moreover, we begin too late; the child's desire to observe and experiment, to reason on the basis of observations made and from the results of experimental inquiry, must be fostered in every way. Mr. Lyttelton, in "Schools and Schoolboys," proposes that there should be no "science proper" in the earlier years of school life. "My contention," said Prof. Armstrong, "is that there should be little else than *proper science*; but then my definition of science is 'the business of knowing.'"

In order to develop the right attitude of mind in our pupils, we must despecialise our science teaching as well as our curriculum as a whole. Work must begin with practical arithmetic, dealing with materials of natural origin and ready to hand. The natural history of the garden pebble may provide the first steps in geology, physiography, and physics. When common materials have been studied—mainly from the physical point of view—it will be time to lay the foundations of chemical belief, and the rusting of iron (leading to combustion) and the study of limestone (leading to acidic and alkylic oxides) provide a good approach. The conception of structure should be developed by the thorough study of alcohol (leading to food and its functions). Plant life, and, later, human anatomy, should be studied, nor should Darwin's work be neglected. Every person of intelligence must be able to appreciate common natural objects and phenomena. Since the work must be done by the boys themselves, a revolution in school procedure will be needed, and science masters should be revolutionaries.

Our space does not admit further excerpts from this comprehensive address. We endorse many, but not all, of Prof. Armstrong's opinions; we give him credit for rendering to the association the service most needed at the present hour. Nothing can better promote educational efficiency than to force schoolmasters into a position of preparedness to give a considered judgment upon the *broader issues* involved in the organisation of curricula and methods—what to teach, why to teach it, and how. If teachers cannot become professionally articulate, these questions will be decided by amateur or professional organisers without their guidance and with disastrous national results.

The programme of the meetings was as follows:—

January 12, Mathematical Association:—President's address, by Prof. H. H. Turner; (2) Mr. C. Godfrey on different methods of teaching algebra for different classes of students; (3) Prof. P. J. Harding on elliptic trammels and Fagnano points; (4) Mr. W. J. Dobbs on an inexpensive balance; (5) Rev. J. J. Milne on the geometric interpretation of homographic equations and their application to loci; (6) Mr. T. J. Garstang on alternatives to Euclid's parallel postulate.

Mathematical and Science Masters' joint meeting:—(1) Address from the chair by Prof. Forsyth; (2) report on correlation of mathematical and science teaching, presented by Mr. C. Godfrey and Mr. D. Berridge.

January 13, Science Masters' Association:—(1) President's address, by Prof. H. E. Armstrong; (2) Mr. J. R. Eccles on simplification of symbols in physics text-books; (3) Mr. L. Cumming on advisability of teaching all boys the elements of geology and biology; (4) Mr. W. E. Cross on laboratory equipment and design; (5) Mr. F. M. Oldham on the teaching of oxidation and reduction.

There was an exhibition of apparatus and books. The apparatus of leading firms displayed steady improvement in working qualities, and received considerable attention. Sir E. Ray Lankester is the president-elect for the year 1911.

G. F. D.

NORTH OF ENGLAND EDUCATION CONFERENCE.

THE conference which met on January 6–8 in the buildings of the University of Leeds, under the presidency of Sir Nathan Bodington, Vice-Chancellor of the University, was the eighth of a series of meetings which have been annually convened in the larger centres of the north of England. There was a large attendance of teachers, administrators, and members of education committees, the total falling little short of 2000 persons. The publishers' exhibition in connection with the conference was frequented throughout each day, and the papers which were read were followed with interest by large audiences, and gave rise to a number of animated discussions.

Prof. Sadler opened on the morning of January 7 with an examination of "The Relation of Elementary Schools to Technical Schools, Day and Evening." An abridgment of his paper appeared in NATURE of January 13, so it is unnecessary to make more than a brief reference to it here.

Some of the chief difficulties in the way of further education for children from primary schools were traced by Prof. Sadler to the snapping by the factories of the educational tradition associated with the old apprenticeship system. Too many English parents now think that a child's education ends when he leaves the elementary day school, while our employers and foremen have lost the sense of responsibility for the further education of the young people in their employment. Substantial reform can only be attained after a completion of the change in public opinion now in progress, and by the re-enlistment of the great employers to the cause of continued education. As regards the legislative measures that will eventually be required to extend the powers of local authorities in dealing with technical continuation classes, and to secure regularity of attendance, Prof. Sadler advocated the recommendations of the Consultative Committee of the Board of Education.

Mr. James Baker contributed to this discussion an account of the system of continuation schools in Austria, from which it appears that apprentices to a great variety of trades are bound to attend regularly the industrial schools of their townships after leaving the elementary schools at the age of fourteen, and that employers are bound to allow the necessary time for such attendance.

Mr. J. H. Reynolds urged that the half-time system demanded by employers must be postponed until after the children's fourteenth year.

On Friday afternoon, January 7, Mr. Max Muspratt, J.P., C.C., opened the discussion on cooperation between employers and education authorities. He cited (as Prof. Sadler had also done) the example of certain large firms (Messrs. Brunner, Mond and Co., Northwich; Messrs. Lever Brothers, Port Sunlight; and the United Alkali Co., Widnes) the directors of which bound all their young employees to attend evening classes up to the age of eighteen or nineteen, the firms paying the fees. This system of friendly compulsion is rendered possible by the fact that the large works in question practically monopolise the labour market in their respective areas; but in the larger towns, owing to the difficulty of bringing the hundreds of offices and firms into line, the only solution is to give powers to local authorities to start some form of compulsory attendance at evening schools up to the age of sixteen for office boys and apprentices. In Liverpool the big engineering shops, *e.g.* of the Dock Board and the White Star and Cunard lines, offer a variety of inducements to apprentices to continue their education, and a similar beginning has been made in a variety of other trades (building, painting, plumbing, &c.).

Mr. V. A. Mundella described the scheme under which the Associations of Shipbuilders and Engineers of Sunderland cooperate with the Sunderland Technical College in the training of engineering apprentices.

Mr. R. Wallace, of the Wallsend Shipway and Engineering Company, and vice-chairman of the Wallsend Education Committee, said that any attempt to educate the masses beyond their capabilities would not benefit them, and would be a waste of the nation's resources. They were dissatisfied with elementary education, and with good cause. What they needed was skilled handicraftsmen.

On the morning of January 8 Mr. J. C. Medd opened the discussion on "Education Abroad and in England," and we hope to find space for an abridgment of his paper in another issue. Mr. Medd considers that the facilities for technical and scientific instruction are as great in England as in Germany, but the German has the advantage in the better quality of the pupils who attend those colleges and schools. In elementary education there is a great need for more practical instruction, some relaxation of the regulations as to building and equipment for manual instruction and domestic science, and the introduction of a system of supplementary courses.

Mr. Otto Siepmann attributed the high average excellence of elementary education in Germany partly to the thorough six-years' training which intending teachers receive in the training colleges, and partly to the fact that the field from which the teachers are drawn is not denuded of its most gifted scholars by any "educational ladder" which leads to other spheres of activity. In the secondary schools, also, individual prominence is sacrificed to raise the common average. All subjects are done in form, and practically the whole form is promoted from one stage to the next. Thus a particular aptitude for a special subject is never developed at school, but the German system ensures for every boy a sound general education. At the universities all this is changed, and the freedom which students are allowed in the choice of subjects, the general lack of supervision and of interim examinations, react favourably upon their work. They carry into life an active interest in some branch of knowledge, which they frequently pursue as long as they live.

Limitations of space prevent any reference to the discussions on art subjects and physical training, and allow merely brief reference to two other topics.

Miss Burstall admitted that the young people who now leave our secondary schools are to a large extent lacking in self-reliance and the power of independent work. She attributes this result to the pressure of the examination system, which forces the teacher, almost in self-defence, to do for the children half the work of gaining, arranging, and applying knowledge. Independent work by the scholars requires more time, which can be got only by reducing the number of subjects studied in any one year. The first thing to aim at, therefore, is to lighten the pressure of examinations.

Mr. W. B. Steer urged that much could be done to encourage independent habits of study by substituting silent reading, followed by keen questioning, for the ordinary reading lesson. At present excessive teaching leaves scant time for learning. Mr. E. E. Unwin spoke of the leisure-hour work and other forms of independent study practised in Bootham School, York.

On "The Relation of the State to the Training of Teachers of Domestic Subjects, and their Relation to the University," Prof. Smithells urged that the time had come for incorporating the training schools of cookery and other domestic subjects in an improved scheme for the general training of teachers, and for treating this important branch of work with less parsimony than hitherto. The domestic training schools should form an integral part of the women's training colleges, though not necessarily in the same building. At the same time, there was no reason except that of expense why a fuller curriculum of training in branches of knowledge relating to these subjects should not be provided in our modern universities, which already function as day training colleges for teachers seeking a more extended knowledge and the attendant degree in arts or science.

Miss M. Atkinson spoke of the introduction in London King's College for Women of two courses in domestic science, one for undergraduates and the other for post-graduate students. It was necessary in domestic economy to draw a sharp line somewhere between the minimum of hygienic knowledge and domestic skill, which should form a part of the education of everyone, and the specialised technique to be demanded of those who proposed to be experts in the subject; but in regard to the latter class especially, the basis of the training should be real and not sham science. The preliminary studies in physics, chemistry, physiology, and economics should consequently be provided by first-year courses at the university in these subjects, exactly as for students of engineering or medicine.

THE ETHNOLOGY OF CALIFORNIA.

THE University of California, continuing its useful work of investigating the ethnology and languages of the now rapidly disappearing Indian tribes of that State, publishes in the third part of the fifth volume of its Proceedings a monograph, by Mr. P. E. Goddard, on the Kato tribe, a branch of the Athapascan race on the Eel River. They have undoubtedly assimilated much of their culture from contact with the Pomos to the south and the Yukis to the east and west; but they still retain so much of their primitive folk-lore and beliefs that they deserve special examination. While their legends of the origin of fire and the sun are more or less common to other members of the group, their accounts of the creation and the deluge are peculiar to themselves. In the first, the earth with its great long horns raises itself from the primeval waters. The god Nagaitcho takes his seat upon it, places its head in the direction in which it should lie, and spreads clay between its eyes and upon each horn. Finally, in this he plants trees and other vegetables, and moulds the mountains and valleys.

In a second myth the gods Nagaitcho and Thunder cause the old, worn-out sky to fall, and replace it with a new firmament with four portals and four supporting columns, preparing at the same time summer and winter trails for the sun. Then follows a deluge, and the creation of fish and beasts of the sea. They then make man out of clay and woman out of one of his legs. In another myth Coyote steals the sun, which he finds tied up in a blanket in the house of an old woman. Out of pieces of the sun he creates the moon and stars. This series of myths, with other folk-tales, has been taken down from the lips of Bill Ray, who is apparently the last member of the tribe acquainted with the race traditions. Mr. Goddard has published the legends in the native language with an interlinear translation, and adds a free version which renders them intelligible. He admits that the record is fragmentary, and that they have probably lost some of their primitive form; but even with this qualification they will prove of interest to students of comparative mythology.

SOME APPLICATIONS OF MICROSCOPY TO MODERN SCIENCE AND PRACTICAL KNOWLEDGE.[1]

THE time is past when a man can expect to make any real contribution to knowledge by spreading his observations over the whole vast range of microscopic objects. In these days, in which the output of research on every subject is enormous, and is increasing rather than diminishing, a man is more likely to make progress and do useful work by taking up a special line and sticking to it. Speaking for those who work *with*, rather than *at*, the microscope, I would advise everyone who wishes his work to be fruitful in results to have a hobby of his own. In making this suggestion, I do not mean that we are all to become narrow specialists, interested in nothing but our own particular subject. Specialisation in work and in research does not necessarily mean specialisation in knowledge or in interests. The great value of such a club as ours is that by bringing together people occupied in different branches of work it enables one man to know what another man is achieving in a different line, thereby at once widening his outlook and stimulating him in his own work by producing a healthy spirit of emulation.

My advice, therefore, to the microscopist would be that he should aim at wide knowledge and diffuse interests, but should concentrate his activities and focus his attention on his own particular pet hobby, so that, by mastering a branch of natural knowledge, he may find himself in a position to advance it. However limited the field of study may be, however insignificant the objects may appear, yet something can always be found which, on the one hand, will illustrate some important and fundamental principle, or, on the other, will prove ultimately to have some direct or indirect bearing on human life and its needs. Let me give two instances in support of this statement. To the so-called practical man it may seem a very trivial occupation to worry about such things as Foraminifera, however beautiful their shells may be. Yet these tiny creatures, living in a sphere apparently so remote from our own, furnish wonderful illustrations of the powers and activities of primitive living matter, and Mr. Earland has recently directed our attention to the remarkable property they exhibit of selecting particular materials for building up their houses. This is a most interesting fact, well worthy of further study, especially by experimental methods, for it indicates that the most primitive and formless living matter possesses faculties of a kind which we term in higher forms of life instinct or intelligence. Again, a reputation for being an expert on, let us say, fleas, may provoke a smile from the uninstructed; but in view of the proved connection between fleas and human disease, especially plague, these paltry insects have now assumed very great importance as objects of study, and we find detailed descriptions of them in the reports of Government commissions. As Lord Crewe remarked in a recent speech, we commonly speak of any very trivial annoyance as a flea-bite; but we know now that in certain circumstances a flea-bite may cost a man his life. Small wonder, then, that fleas have become important objects of study to mankind.

This question of fleas and plague reminds me that I am here, not to preach a sermon, but to give an address, by recalling to my mind the subject which I propose to discuss to-night, namely, some of the remarkable advances that have been made during the last few years in our knowledge of human diseases caused by microscopic parasites. This is a subject which has now grown to such vast proportions that I must confine myself of necessity to a small part of it, namely, the diseases caused by Protozoa. As examples, I shall deal more especially with malaria, sleeping sickness, and yellow fever.

Malaria is a disease which was well known to the ancients, and is still very rife in many parts of Europe. It appears to have been prevalent formerly in the fen districts of England, but to have died out there from some unexplained reason. It is estimated by Prof. Ronald Ross to cause from a quarter to half the total disease in the tropics. It occurs under at least three forms, known commonly as tertian, quartan, and pernicious malaria, each of them easily distinguishable clinically, and due to distinct species of the parasite differing from one another in morphological characters, but similar in the general features of their life-cycle.

Until comparatively recent times nothing whatever was known of the nature of malaria or the manner in which it was acquired. It was generally believed that it was due to a poisonous miasma which arose from swamps and marshes, a notion conveyed in the name malaria—"bad air." This miasma theory is very prevalent in literature; for instance, in such a work as Dickens's "Martin Chuzzlewit," where the unfortunate settlers in Eden are supposed to contract fever by breathing the exhalations of the swamps.

The scientific study of malaria may be dated from 1880, when the parasite was discovered in the blood of fever patients by Laveran, then a military surgeon in Algiers. Laveran examined the blood microscopically, and observed the principal phases of the parasite. It was, however, some years before Laveran's parasite was accepted as the cause of malaria, though it ultimately obtained universal recognition. Even then it remained a mystery how the parasite got into the blood, and many still held to the miasma theory. It was supposed by some that the parasite passed out of the body and produced cysts or spores which could be disseminated by the wind, just as the cysts of many Infusoria are known to be carried by aërial currents, and that by inhaling these air-borne germs the disease was acquired. Others sought for the source of the infection in the contamination of drinking-water.

It remained for a countryman of ours to discover the true method of infection. Prof. Ronald Ross, then in the Indian Medical Service, experimented first with the very similar malarial parasites of birds, and found that the infection was taken from one bird to another by mosquitoes of the genus Culex. Similar experiments on human malaria gave at first negative results, until it was discovered that the necessary intermediate host of human malaria was a mosquito belonging to quite a different genus, Anopheles. These experiments were confirmed by many investigators in all parts of the world, and led to results which may be stated in two propositions, one positive, one negative, first premising that by a malarial infection is meant a new infection, not a relapse in a person previously infected.

(1) Malaria can be and is conveyed from sick to healthy persons by the agency of mosquitoes.

[1] From the presidential address delivered to the Quekett Microscopical Club on May 7, 1909, by Prof. E. A. Minchin, and published in the Journal of the Club for November, 1909.

(2) Malarial infection is not known to take place by any other method.

Experiments further showed, as I have mentioned already, the very remarkable fact that avian malaria can only be transmitted by culicine mosquitoes, and human malaria only by anopheline. If human blood containing the parasite be taken up by a Culex, the parasite cannot develop, but is digested up, along with the blood. The same thing happens to the parasite of avian malaria when taken up by an Anopheles.

Following on these experimental discoveries, the development of the parasite was studied microscopically in all countries by a great number of observers, amongst whom we may mention especially Grassi in Italy and Schaudinn in Germany. By their combined labours the complete life-history of the parasite has been worked out in the greatest detail, revealing one of the most fascinating chapters in natural history.

(An account was then given of the development of the malarial parasite, illustrated by a diagram.)

My second example, sleeping sickness, is also a disease that has been long known, though without attracting, until recently, so much attention as malaria. It was first observed in the West Indies in negro slaves imported from the west coast of Africa, the region in which it appears to be endemic. It was observed that the negroes suffering from it were not infectious, and that the disease did not spread to others—a fact easily explained by what is now known about the transmission of sleeping sickness, namely, that it is effected by flies of the genus Glossina, commonly known as tsetse-flies, which are confined at the present time to the African continent.

Of recent years this previously obscure disease has forced itself on the public attention by its having spread from its native haunts on the west of Africa and invaded regions previously free from its presence. In our protectorate of Uganda, in particular, it has caused terrible mortality, completely extirpating the natives in some parts, and numbering also many Europeans amongst its victims. I do not propose here to enter into the distressing symptoms of this deadly disease, but only to deal with what may be termed its natural history.

Before it is possible to understand clearly the nature of sleeping sickness it is necessary to say a few words about similar diseases in animals. It was well known to all African travellers from the time of Livingstone that domestic animals, especially cattle, horses, and dogs, were liable in Africa to a peculiar fatal disease known as nagana, caused by the bite of blood-sucking flies of the genus Glossina, the tsetse-flies, of which there are several species abundant in various parts of Africa. It was supposed that the fly produced and injected a virus which caused the disease.

The nature of nagana was first made clear by Sir David Bruce, who found that the cause of the disease was the presence in the blood of a minute flagellate or trypanosome, since named *Trypanosoma brucii*, and that the tsetse-fly did not generate the parasite, but was merely the unwitting agent in transmitting it from infected to healthy animals.

When the epidemic of sleeping sickness broke out in Uganda, the Royal Society, at the request of the Government, appointed a commission to investigate it, and Sir David Bruce was sent out as a member of the commission. A trypanosome was found by Castellani in the cerebro-spinal fluid of sleeping-sickness patients, and it was shown by Bruce and his assistants that this trypanosome was the cause of the disease, and that it was transmitted from sick to healthy persons by the bite of the local species of tsetse-fly, *Glossina palpalis*. It was proved by subsequent researches that the trypanosome causing sleeping sickness was identical with one that had been discovered previously in the blood of negroes in Gambia, and named *T. gambiense* by Dutton. In short, it was proved that sleeping sickness of man is a trypanosome disease similar to nagana of animals, but produced by a different species of trypanosome, transmitted by a different species of tsetse-fly, and running a somewhat different course. Whereas *Trypanosoma brucii* remains in the blood of its victims until their death, *T. gambiense* is found in the blood in the early stages of the disease, but spreads, probably through the lymphatic channels, into the cerebro-spinal fluid, and then causes the peculiar nervous symptoms which give the disease its name. The rapid spread of sleeping sickness into regions where it was previously unknown is an indirect consequence of the occupation of the African continent by European Powers. Formerly the native tribes were constantly at war with one another, and a negro never travelled any great distance from his own village. Now caravans move in every direction, and doubtless in this way the disease has been spread by porters and other natives already infected with the trypanosome coming into regions where tsetse-flies abound, and there infecting the flies, which in their turn have disseminated the infection amongst the previously healthy population.

Although it was proved experimentally that the disease is propagated by tsetse-flies, the exact method by which this is effected has remained hitherto somewhat mysterious. It was proved that the infection could be conveyed by what may be termed the direct mechanical method; that is to say, if a fly has sucked recently the blood of an infected person, its proboscis may contain living trypanosomes, and if it inserts its proboscis, immediately or a short time afterwards, into the skin of a healthy person, it may convey the infection simply by means of its contaminated proboscis. Experiments showed that infection in this direct manner only took place up to forty-eight hours after the fly had fed on the infected subject, and all attempts to obtain infection with flies at a longer interval than forty-eight hours gave negative results. Experimental evidence was therefore lacking for the existence of a developmental cycle of the parasite in the fly, although it was argued by many writers that for various reasons such a cycle must exist. Quite recently, however, a positive result has been obtained by Prof. Kleine, director of the German Sleeping Sickness Commission in German East Africa. Experimenting with nagana by feeding a batch of flies first on an infected animal and then on a long succession of healthy animals, he has made the most interesting and important discovery that the flies are not infectious at all until some three weeks after their first feed, and that then they infect every animal upon which they are fed. This result indicates that the incubation period—that is to say, the time occupied by the parasite in its cycle of development in the fly—is far longer than anyone had suspected, and that the negative results of former investigators are to be explained by their experiments not having been extended over a sufficiently long period. It must be borne in mind that to those working in tropical Africa it is often difficult, or even impossible, to obtain a sufficient number of experimental animals for such a protracted series of experiments.

From Prof. Kleine's experimental results it is evident that the trypanosome of nagana, and doubtless of sleeping sickness also, does undergo a cycle of development in the tsetse-fly, and the way is now open for the microscopist to rush in and to observe what becomes of the parasite in this long period that elapses between its being taken up by the fly and being given out again. We may expect that a fascinating and wonderful history will be made known of the transformations and migrations, the amours and the increase of the trypanosome in the bowels of the unconscious tsetse-fly; and we seem now to be in sight of a solution to the baffling problem of the transmission of diseases caused by trypanosomes.

The third disease I have chosen for my discourse, namely, yellow fever, is one sufficiently well known to everyone, by repute at least. There is no need for me to describe at length the dreaded "Yellow Jack," a malady often fatal, and always excruciatingly painful. The connection of this disease with mosquitoes has long been suspected, and has recently been proved conclusively by both the American and French commissions sent out to study the disease. The mosquito in this case is neither a Culex nor an Anopheles, but one belonging to a distinct genus, namely, *Stegomyia fasciata*, sometimes called the tiger-mosquito. It has been proved conclusively that the mosquito does transmit yellow fever, and it has also been proved that the disease is not communicated by direct infection or contagion through contaminated clothes or dwellings; and here let me direct attention to one great obstacle to conducting experiments on yellow fever—the fact, namely, that the disease is not communicable to animals, but only, so far as is known, to man. Hence experimental studies on the disease could only be performed on men who offered themselves voluntarily for this purpose. Such experiments were sometimes negative, sometimes positive, in their result; in the latter case, of course, the subject of the experiment acquired the disease, and in one case, at least, died of it. It would require the pen of a Shakespeare or a Milton to do adequate justice to such devotion on the part of these brave men to the cause of science and humanity.

By numerous carefully devised experiments a number of important facts relating to the transmission of yellow fever were elicited. It was shown that the unknown cause of the disease is in the blood of the patient only during the first three days of the illness, so that only during this period can mosquitoes become infected by sucking the blood of the patient. Consequently, if the patient be protected from mosquitoes for the first three days he ceases to be a danger to the community as a source from which the infection can spread. It was shown, further, that the mosquito, after acquiring the infection, goes through an incubation period of from twelve to fourteen days, during which it is not infectious; but after that it is infectious for the rest of its natural life; and a further point of interest was added by the French commission, namely, that an infected mosquito may transmit the infection to its offspring, so that a mosquito which has never fed on an infected person may be congenitally infectious.

I have chosen the instance of yellow fever to put before you because, although we have now such an accurate knowledge, gained by experiment, of the cause and transmission of the disease, no one has succeeded as yet in seeing the parasite itself. It is practically certain, for many reasons, that there is some minute parasite at work, and there are grounds for suspecting that the parasite is a spirochæte, one of those minute, actively flexible, thread-like organisms of which the affinities are so much in dispute at present, and which some authorities class with the Protozoa, others with the Bacteria; but here we have a case where the microscopist has been baffled, and where we get beyond the present limits of the powers of our instrument, a fact which should make us appreciate the labours of those who study the microscope and strive to perfect it.

Did time permit, I might mention many more important discoveries in the field of protozoan parasites causing disease. For example, there are the blood parasites of the genus Piroplasma (Babesia), causing fatal forms of hæmoglobinuria in various animals; they are not yet known for certain in man, but a species is known from monkeys, a source which is getting perilously near to us. Here the agent of infection is a tick of some sort, and usually the infection goes through two generations of ticks, being transmitted from the mother-tick, which has acquired the infection, to the numerous progeny of minute six-legged tick-larvæ, which in their turn infect the vertebrate host. Then there are the relapsing fevers caused by spirochætes in the blood, and said to be transmitted in Europe by bed-bugs, but in Africa by a species of tick which lives in mud floors. In India and other parts of the tropics we find that the deadly disease known as kala azar, due to a parasite, is transmitted in all probability by bed-bugs. All these and many others furnish points of great interest, but I must be content with the three examples with which I have dealt in more detail, in order to show you how great a work has been done and is being done in this field. As Prof. Osler said recently, these discoveries are going to have an enormous influence on the history of the world and of mankind, because they are going to make the tropics habitable by white men. We hear or read so often of such-and-such a country being uninhabitable by Europeans on account of its deadly climate; but when we look into the matter we find that it is not the climate at all that is to blame, but that the white races are killed off by diseases caused by some animal parasite with which they are inoculated by the bite of some bloodthirsty arthropod. Take Uganda, for instance, with which I have a slight acquaintance; all that the climate does for you there is to give you a sunstroke if you go out in the heat of the day with inadequate headgear, and to make it very difficult to keep awake after lunch. Some well-known European diseases, such as small-pox and syphilis, are also rife there; but, on the other hand, some of our familiar plagues, such as tuberculosis, rheumatic fever, and influenza, appear to be absent. The diseases that are really to be feared are all such as spring from bites of arthropods. If you protect yourself from the mosquito you will not get malaria; avoid the tsetse-fly, which is very easily done, and you are safe from sleeping sickness; do not sleep on mud floors, nor pitch your tent on old encampments, and relapsing fever will not trouble you; keep rats and fleas at a distance, and you are safe from plague. With a little care and attention to surroundings the European finds his life in the tropics, if anything, more free from disease than in our temperate but influenza-ridden Palæarctic climate.

In the foregoing remarks I have directed attention more particularly to the practical results of microscopy wedded to sagacious experiment, and have tried to show how fertile in good results this union has been, and promises still to be; but I would not have you go away with the impression that I advocate such studies solely on account of immediate practical good to be derived from them. Far from it. I am one of those who hold so-called theoretical and unpractical studies to be of the highest importance, and worthy of all support, if only for the reason that, being unremunerative, they often cannot support themselves. All history shows us that the knowledge of general principles must precede their application and practice, and that what is purely theoretical in one generation becomes thoroughly practical in the next or in a later one. There is no need for me to waste your time by multiplying instances of this familiar truth; but I will conclude with a few words on the wider applications of microscopy.

In the range of the natural sciences, two branches of knowledge stand at opposite poles, as judged from the standpoint of the objects with which they deal. The science of astronomy deals with the infinitely great; the science of biology, on the other hand, with the infinitely small. The astronomer with his telescope astounds us with the distant worlds he reveals to us; he thinks in millions of miles as ordinary persons deal with feet or yards; and he exhibits to us this world on which we live as but an insignificant planet, one of many, whirling round a star far inferior in magnitude to many of those we see nightly, a tiny speck in the vast ocean of space and matter, peopled by a race of puny creatures who style themselves the lords of creation, although their dominion does not extend over a billionth part of the universe. "The consciousness of an endless series of worlds," said Kant, "destroys my sense of importance, making me only one of the animal creatures which must return its substance again to the planet (that, too, being no more than a point in space) from whence it came, after having been in some unknown way endowed with life for a brief space."

Not less astounding, but in a totally different way, are the revelations of the biologist with his principal instrument of research, the microscope. With this he discovers continually new worlds invisible to the unassisted eye, and reveals infinite complexity in things apparently the most simple. We find, in the first place, our own bodies to be microcosms, small worlds, that is, of such inexhaustible variety and elaboration of detail that to the human mind they are as difficult to comprehend and to realise in their entirety as the macrocosm or great universe itself. We find, further, that each human body, itself appearing as a single individual or unit, is in reality made up of many billions of living units or cells, each as much a microcosm as the whole body; and thus our instrument, the microscope, brings us face to face with the greatest mystery in the whole range of the sciences, namely, the problem of life and living matter. There is, apparently, no gap in nature so profound as that which separates the living from the not-living. The nature of life, its origin and destiny, the laws that govern living matter and vital processes of all kinds, these are of all problems not merely the most fundamental in science and philosophy, but also the most important for our practical knowledge and daily conduct.

It would be futile to assert that human science has as yet made any great advance in elucidating the nature of life. On the contrary, all progress in research only throws into greater relief the difficulty of the problem; the better we become acquainted with it, the more the mystery deepens. Nor would it be right to assert that the microscope is the sole instrument of research in this field. Our knowledge of the properties and activities of the living substance and of living things advances daily by leaps and bounds through methods of investigation in which the microscope plays no part. I have referred to the knowledge that has been gained of the life-history of the parasite of yellow fever, in spite of the fact that the microscope has failed completely, so far, to detect the parasite itself. But we may safely claim that the greater and most important part of modern biological knowledge could not have been gained without the instrument which it is the object and purpose of our club to study, to perfect, and to apply; and, further, that to be able to see the objects with our own eyes makes them much more real and true to us than merely to infer their presence and properties from experiments in the dark, so to speak. "Seeing is believing" is an English proverb which has its counterpart in all languages. We may be satisfied in our minds as to the existence and behaviour of the yellow-fever parasite, but nevertheless its discovery by optical means would be greatly welcomed as an important advance in our knowledge.

There is no greater stimulant to the all-important study of living things than the feeling of wonder and delight which the first sight under the microscope of objects otherwise invisible produces in even the most uninstructed mind. Most of us probably can date our first interest in minute living objects from the time when, perhaps in early youth, we were given, or allowed to use, a microscope, with which we could gratify, without satisfying, our curiosity in looking at all kinds of minute objects. In such an occupation the appetite comes with eating, as the French proverb says, and the instrument which was at first a fascinating toy leads us on until, one might almost say, it masters and enslaves us. In this development there is another instance of the parallel between the progress of the individual and the history of the race. To the majority of early microscopists the microscope was but a toy, an instrument which competed with the magic-lantern as an amusement for drawing-room séances, and only a serious minority made use of it as a means of earnest scientific investigation. There are, perhaps, still microscopists whose chief delight is to thrill their friends, especially those of the fair sex, by the sight of hairs on a spider's leg, or the elephantine proportions of a cheese-mite. If so, let us not scoff, as some do, at the amateur; we ought rather to regard him with the same interest that a zoologist looks on an okapi or a lepidosiren, as a living representative of a bygone age. For the modern microscopist is fearfully in earnest, and has but little opportunity for amusement in pursuing a science which taxes, not only his brain, but his eyes to the utmost. There is scarcely any greater physical strain than the long-continued investigation carried on with the highest powers of the microscope, and in my own experience I have known some who lacked the physical endowment for such work, and others who have been obliged to retire disabled from the field. Let us, then, in a pursuit which but too frequently dulls enthusiasm by fatigue and exhaustion, in which our "native hue of resolution" tends to become "sicklied o'er by the pale cast of thought," rather envy those who retain the freshness of their early delight, and strive to cultivate, rather than to stifle, that feeling of wonder and curiosity which should be the starting point of all philosophical and scientific investigation. "Two things," said Kant, "fill my mind with ever-renewed wonder and awe, the more often and the deeper I dwell on them—the starry vault above me and the moral law within me." I venture to think that had Kant lived in our days he would have found a third source of wonder in the contemplation of the simplest living things as revealed by the microscope, in the combination they present of apparent simplicity with infinite complexity, and of extreme minuteness with the most extraordinary powers. To me the observation of a minute organism, such as an amœba, under the microscope, is in its way as marvellous as the sight of the starry firmament. I see a minute, formless creature, without definite parts or organs, which nevertheless exercises all the functions of life and exhibits the germ of every faculty we possess, and thereby proves that its apparent simplicity and formlessness cloak a complexity of organisation far transcending our powers of observation and eluding our means of detection. What, again, can be more wonderful to contemplate than the fact that peculiarities in the complex mental endowment and physical structure of a human being can be transmitted from one generation to the next through the medium of a spermatozoon, the tiniest cell of the human body, in which the microscope reveals only a structure of the simplest kind? These things must rank with the most wonderful and inexplicable of the phenomena that nature presents to us, and we are as yet only on the threshold of investigation. The stellar universe has been observed, its laws and motions studied, for many thousands of years, but our acquaintance with the beginnings of life and its properties as exhibited by the simplest living things is but an affair of yesterday, as it were, and the scientific study of life is as yet in its infancy.

In these days of vast and rapid increase of knowledge in such matters there is danger that we may lose the true perspective, and that our perception of the whole may be blunted and obscured by the immense mass of detail which forces us to attend only to a small part of our science. It is the special function of a club such as ours to keep fresh our enthusiasm and to enlarge our outlook by contact and intercourse with those working in other fields, to spread the infection, if I may use the term, of intelligent curiosity in the minutest natural objects, and thereby to attract and enlist new workers in a field in which the harvest is plentiful but the labourers are few.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The electors to the Allen scholarship give notice that they are prepared to receive applications from candidates. Any graduate of the University is eligible for the scholarship provided that his age on the first day of the Lent term, 1910, does not exceed twenty-eight years. This year the scholarship is open to candidates who propose to undertake research in any branch of study which comes within the department of any of the following special boards:—medicine, mathematics, physics and chemistry, biology and geology. The scholarship is tenable for one year, during which period it will be the duty of the student to devote himself to research in Cambridge or elsewhere. The emolument of the student is 250*l*., or such smaller sum as the fund, after payment of all expenses, shall be capable of providing. Every candidate must send to the Vice-Chancellor, Pembroke College Lodge, on or before February 15, his name and a definite statement of the course of research which he proposes to undertake, together with such evidence of his qualifications as he thinks proper, and with the names of not more than three referees to whom the electors may apply for information.

THE University of California has received from Mrs. Phœbe Hearst an offer to build, at the cost of about 100,000*l*., a museum for the housing of its anthropological specimens. During the last ten years Mrs. Hearst had already contributed an equal sum to the establishment and maintenance of the University's department of anthropology, and to the cost of its foreign expeditions.

ACCORDING to the Berlin correspondent of the *Times*, the latest returns from the German universities give the total number of students as 52,407, including 1850 women, as compared with a total of 48,730 last year and 32,800 ten years ago. There are also 3314 men and 1923 women attending courses as guests. Berlin takes the first place among the twenty-one universities with 9242 students, as against 8641 last year, and is followed by Munich with 6537, Leipzig with 4761, Bonn with 3652, Breslau with 2405, and Halle with 2393. Göttingen has 2230, and Heidelberg 1934. In Berlin University this winter there are 632 women students, an increase of 232 as compared with last year.

AN address delivered by Prof. Alexander Smith before the section of education of the American Chemical Society at Detroit, and reproduced in a recent number of *Science* under the title "The Rehabilitation of the American College and the Place of Chemistry in It," is of more than local interest and importance. The author is strongly impressed with the difficulty of teaching his subject effectively to classes of students of widely varying mental capacities, and especially of teaching it in such a way as to be of service to those who do not expect to become professional chemists. He is a profound disbeliever in the method of imparting instruction which relies mainly upon lectures, and urges that the essential feature of all teaching should be "problem-solving" in some form or other. This method, he suggests, is fully developed in the teaching of languages, in which "the grammar furnishes the laws and general principles, together with all the known exceptions," "the dictionary supplies the isolated facts," and "the text provides the subject of study in constant and definite form." In the case of chemistry, he urges a closely interwoven scheme of laboratory work and class-room discussion, supplemented (if lectures are used) by briefly written answers to set questions and home study in varying amounts to suit the necessities of the individual student.

THE annual general meeting of the Association of Headmasters was held in London on January 12 and 13. Mr. Philip Wood, headmaster of Darlington Grammar School, the president for the year, in his presidential address referred to the question of the provision of free places in secondary schools receiving grants from the Board of Education. He said there are many grammar schools in towns with a population of less than 20,000 which educate the sons of the professional people and better-class tradesmen, but depend largely for their existence on being able to attract boarders. The position of such a school at the present time is very precarious. It has had always something of a struggle, and the grants of local education authorities and of the Board of Education are just what it requires to give it new life; but the grants are conditioned, and the conditions, at least of the Board of Education, would seem to contemplate a large day school in a large town rather than the kind of school in question. In a small market town, for instance, it is ridiculous that a school of, perhaps, seventy-five boys should be increased to 100 in order to provide for the education of twenty-five boys from the two or three elementary schools in the town. Boys capable of taking advantage of these opportunities are not to be found; and what is also a matter of common experience, their admission, whether they are capable or incapable, generally means the displacement of an equal number of boys whose parents do not like the new situation. Thus the 25 per cent. rule, which does not greatly embarrass a large day school, will, if rigorously applied, almost ruin many schools which we can ill afford to lose.

THE Department of Agriculture and Technical Instruction for Ireland has issued a pamphlet giving an account, by Mr. George Fletcher, assistant secretary for technical instruction, of the summer courses of instruction for teachers instituted by the Department in 1901. The courses are held in July and August, and extend over a period of about a month. They are held in Dublin and elsewhere. In selecting teachers to attend the courses, regard is had to the qualifications of the teachers and the needs of the school or district from which they come. After each year's course, teachers who pass the examinations are provisionally recognised as qualified to teach the subjects in which they have passed. Courses are held in experimental science, drawing, manual work in wood, and domestic economy. Besides preparing teachers to conduct classes in the Department's "Programme for Day Secondary Schools," the summer courses are year by year coming to serve a further purpose. Side by side with the development of the Department's scheme in day secondary schools there has grown up a system of specialised technical education all over Ireland. The rate of growth has been rapid, and a large and increasing number of Irish teachers are engaged in the schools and classes organised through urban and county councils. While it was necessary in the initial stages of such a system to employ teachers having experience of similar work, from whatever source they might be obtained, special efforts have since been made to train Irishmen when and where possible. Hence it is that year by year an increasing number of summer courses are organised to deal with subjects purely technical in character and having for their object the further education and training of teachers already engaged in Irish technical schools. It would be difficult to over-estimate the value of these courses as an element of educational progress. The typical courses described in the pamphlet by means of syllabuses, descriptions, and illustrations indicate what great pains have been taken by the authorities to make the lectures and practical work meet the needs of the teachers exactly.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 13.—Sir Archibald Geikie, K.C.B., president, in the chair.—Sir Edward **Thorpe** and A. G. **Francis**: The atomic weight of strontium.—L. F. **Richardson**: The approximate arithmetical solution by finite differences of physical problems involving differential equations, with an application to the stresses in a masonry dam. In order to deal with irregular boundaries, analysis is replaced by arithmetic, continuous functions are represented by tables of numbers, differentials by central differences. Then problems fall into two classes. (A) The relation between the equation obtaining throughout the body and the boundary condition is such that the integral can be stepped out from a boundary. This class includes equations of all orders and degrees. It has been treated by arithmetical differences by Runge, W. F. Sheppard, Karl Heun, W. Kutta, and Richard Ganz. Examples of a specially simple method are given. (B) The integral must be determined with reference to the boundary as a whole, as in Dirichlet's problem. The method given has only been worked out for a limited group of linear equations, namely, for those in connection with which a function analogous to potential energy exists, which is a complete minimum when and only when the difference equations are satisfied. Under this condition the difference between the integral ϕ_u and a function ϕ_1 of the independents, having the correct boundary conditions but otherwise arbitrary, can be expanded in the form $\phi_1 - \phi_u = \Sigma A_k P_k$ where the $A_1s \ldots An$ are constants and $P_1 \ldots P_n$ are "principal modes of oscillation" defined by $D'P_k = \lambda_k^2 P_k$ where $D'\phi_u = 0$ is the difference equation to be integrated and λ^2 is a constant. Now we start with the table of numbers ϕ_1 and calculate $D'\phi_1$. Then as $D'\phi_u = 0$ we have $D'\phi_1 = D'(\phi_1 - \phi_u) = \Sigma A_k \lambda_k^2 P_k$. Multiplying both sides by some number α_1^{-1} and subtracting from ϕ_1, and altering the boundary numbers so that the boundary condition is still satisfied, we have a new table which may be called ϕ_2; and $\phi_2 - \phi_u = \Sigma A_k(1 - \alpha_1^{-1}\lambda_k^2)P_k$. Repeating the process with $\alpha_2 \ldots \alpha_m$ we get:

$$\phi_{m+1} - \phi_u = \Sigma A_k(1 - \alpha_2^{-1}\lambda_k^2)(1 - \alpha_2^{-1}\lambda_k^2) \ldots (1 - \alpha_m^{-1}\lambda_k^2)P_k.$$

Now a function I exists such that $SIP_k^2 = 1$, $SIP_l P_k = 0$ where S denotes a summation throughout the region. Therefore:

$$SI(\phi_{m+1} - \phi_u)^2 = \Sigma[A_k(1 - \alpha_1^{-1}\lambda_k^2) \ldots (1 - \alpha_m^{-1}\lambda_k^2)]^2.$$

Now by a sufficient number of suitably chosen αs the polynomial in λ^2 on the right can be made small throughout the range from λ_1^2 to λ_n^2. Therefore the error of ϕ_{m+1} can be made small; for, since I is one signed it is measured by the L.H.S. The process is arithmetical. The error due to finite central differences is of the form

$$e_2h^2 + e_4h^4 + e_6h^6 + \text{\&c.},$$

where h is the coordinate difference and the es are functions of position independent of h. If the integral has been found for two or more sizes of h, more exact values of it can be extrapolated by this formula. These methods have been applied in the paper to calculate the stress-function in a masonry dam.—A. O. **Rankine**: A method of determining the viscosity of gases, especially those available only in small quantities.—Dr. P. **Phillips**: Recombination of ions at different temperatures.—Dr. G. C. **Simpson**: The electricity of rain and snow. This paper relates to measurements of the electricity of rain made in continuation of those described at the beginning of last year (Phil. Trans., Series A, vol. ccix., pp. 379–413, 1909), and, in addition, to a series of measurements of the electricity of snow made during the winter 1908–9. All the main conclusions drawn from the previous work have been confirmed, and it may now be stated with confidence that in Simla (*a*) more than three times as much positive as negative electricity is brought down by the rain; (*b*) the heavier the rainfall, the more likely is it to be positively charged; (*c*) light rain is, as a rule, more highly charged than heavy rain, irrespective of whether the charge is positive or negative. With regard to the electrification of snow, the measurements indicate that in Simla (*d*) the positive charge carried down by the snow is between three and four times as great as the negative charge; (*e*) snow is generally more highly charged than rain.—L. **Vegard**: The polarisation of X-rays compared with their power of exciting high-velocity kathode rays.

Mathematical Society, January 13.—Sir W. D. Niven, president, in the chair.—Dr. H. F. **Baker**: (1) The theory of the cubic surface; (2) an example of the expansion of a function in a series of polynomials.—G. N. **Watson**: The harmonic functions associated with the parabolic cylinder.—Dr. H. de S. **Pittard**: Note on the theory of sets in probabilities.—H. **Bateman**: The transformations of coordinates which can be used to transform one physical problem into another.—G. H. **Hardy**: Note on a former paper on the theory of divergent series.—Dr. W. H. **Young**: Homogeneous oscillation of successions of functions.—Dr. W. H. **Young** and Mrs. G. C. **Young**: The determination of a semi-continuous function from a countable set of values.—J. E. **Campbell**: Cyclic congruences.

Royal Astronomical Society, January 14.—Sir David Gill, K.C.B., president, in the chair.—J. **Evershed**: Radial movement in sun-spots: second paper. The paper contained further investigations on the spectra of sun-spots, made at the Kodaikánal Observatory, India. The spectra of every considerable spot had been photographed, and it was invariably found that, except when the spot was near the centre of the disc, the lines crossing the spot were inclined towards the red on the side nearest the limb, and towards the violet on the side nearest the centre of the disc. Assuming this inclination to be due to motion in the line of sight, the conclusion seemed inevitable that spots are centres of a force directed outwards in a horizontal plane. This would explain the motion of recession on the side nearest the limb, and of approach on the side nearest the centre of the disc. The effect would not be observed in the case of a spot near the central meridian, where there would be no motion in the line of sight. A study of the calcium lines showed a motion in the opposite direction (towards the centre of the spot), indicating an in-draught of calcium vapour in the higher chromosphere. No evidence was obtained of an upward current over spots, but there were some indications of downward movements. There are also indications of cyclonic motion, but in the opposite direction to that shown in some of Prof. Hale's spectroheliographs.—A. C. D. **Crommelin**: Diagram illustrating a method of charting the geocentric places of a comet referred to a fixed radius vector.—R. W. **Wood**: The moon in ultra-violet light; spectro-selenography. The author recommended a spectroscopic method of investigating the nature of the surface of the moon.

Institute of Metals, January 18.—Sir William H. White, K.C.B., F.R.S., president, in the chair.—G. D. **Bengough** and B. P. **Hill**: The properties and constitution of copper-arsenic alloys. One of the principal objects of the paper was to bring forward data for an authoritative pronouncement upon the best proportion of arsenic to be used to secure copper alloys having greater strength and rigidity, and greater resistance to the corrosive action of gases at high temperatures, than commercially pure copper. The first portion of the paper dealt with the mechanical properties of the alloys of industrial importance, and the second with their chemical composition. In the latter section the authors denied the existence of the compound Cu^2As, proposed by Hiorns, and confirmed the existence of the compounds Cu_3As and Cu_5As_2, already proposed by Friedrich.—E. A. **Smith**: The assay of industrial gold alloys. The author gave a brief comparative description of the methods in general use for the assay of industrial gold alloys, based on experimental work carried out at the Royal School of Mines and in the University of Sheffield. It was shown that the results for gold assay were invariably higher when determined by direct cupellation with parting silver than when determined indirectly by double cupellation.—Dr. R. **Seligman** and F. J. **Willott**: The analysis of aluminium and its alloys. A detailed description was given of the technical methods of estimating the various foreign elements (copper, zinc, nickel, magnesium, tin, lead, manganese, titanium) and impurities (silicon, iron, and sodium) to be found in commercial aluminium and aluminium alloys. It was pointed out that the effect of these elements, particularly in minute proportions, upon aluminium was but little understood, and that it was desirable that research be directed along those lines.

EDINBURGH.

Royal Society, December 20, 1909.—Sir William Turner, K.C.B., president, in the chair.—Sir William **Turner**: The aborigines of Tasmania, part ii., the skeleton. The paper gave further particulars as to the specimens of Tasmanian skulls and skeletons now extant, and described in detail the bone anatomy of the specimen in the museum at Brussels. The discussion emphasised the fact that the Tasmanian had differed in important particulars from the ordinary black races, but resembled them in other respects. As regards the flattened femurs, the Tasmanian suggested affinity with the cave-dwellers and the Maoris, whereas in the form of the pelvis there was greater resemblance to the European races.—W. T. **Gordon**: The structure and affinities of *Zygopteris Römeri* (Solms). The petiole of this form was described by Solms Laubach from the Culm of Falkenberg. A few years later a similar petiole was obtained by Renault from rocks in Autun, and called *Diplolabis Esnostensis*. The present specimens of stems, petioles, and roots were found last year by the author in rocks of Calciferous Sandstone age at Pettycur, in Fife. The stem is protostelic, and is circular in transverse section. The wood consists of an inner zone with short elements, and an outer zone with longer tracheides. All the wood elements, whether long or short, have reticulate thickenings in their walls. The stem branches dichotomously. Appendages are given off from the stem at long intervals. These are either petioles or roots. At successive levels in the petiole the trace is indistinguishable from the characteristic trace in several different genera. *Zygopteris Römeri* is thus a synthetic type so far as the stages in the development of its petiole are concerned, and in the possession of a protostele the plant is the most primitive zygopterid yet discovered. In its organisation it has an important bearing on the origin of the Botryopteridæ and the Osmundaceæ.—Prof. Gwynne **Vaughan** and Dr. R. **Kidston**, F.R.S.: The fossil Osmundaceæ, part iv., and conclusion. Two new species are described, *Osmundites Kolbei* and *O. Schemniciensis*. The latter is closely similar to the modern Osmunda, but the anatomy of the former is described for the first time. It is very interesting owing to the position it takes up between the Osmundaceæ that have a solid xylemed stele and those with a broken ring of xylem surrounding a pith. The xylem is broken up into separate strands, but its pith contains scattered groups of tracheal elements. The general results of the whole paper are summed up, and the relationships between the Osmundaceæ and the Zygopterideæ are discussed in some detail, especially with reference to the peculiarities of the structure of the zygopterid leaf-trace.—Prof. J. C. **Ewart**, F.R.S.: The restoration of an ancient race of horse. About the middle of last century Owen received two upper molar teeth of a small member of the Equidæ family from a cavernous fissure at Oreston, near Plymouth. Similar teeth were obtained from the drift lying over the London at Chatham and from Kesingland, in Suffolk. Owen realised that these molars could not belong to a small variety of *Equus fossilis*—the species now represented by the wild horse (*E. przewalskii*) of Mongolia—but he had some difficulty in deciding whether they were the teeth of a small race of horses or the teeth of an ass or a zebra. Eventually he concluded that the Oreston teeth belonged to a "wild ass or quagga," which, with a wild horse and a wild boar, entered "into the series of British Pliocene hoofed mammals." To this fossil wild ass or zebra Owen gave the name of *Asinus fossilis*. In addition to the last two upper molars there is preserved in the British Museum a first upper molar from Oreston which probably belonged to an animal between ten and eleven hands at the withers. In this small first molar the grinding surface of the "internal pillar"—a fold of enamel on the inner surface of the tooth—is only one-third the length of the grinding surface of the crown. In having a small internal pillar or protocone in this first upper molar, the Oreston type differs profoundly from the wild horse of Mongolia, but resembles (1) the small horses which at the beginning of the Pliocene period lived in Nebraska, *i.e.* horses of the Pliohippus group; (2) a small race which towards the close of the Pliocene frequented the valley of the Arno—a race hitherto included in the *E. stenosis* group; (3) a small variety which in Pliocene times lived in Auvergne and other parts of France, sometimes known as *E. ligeris*; and (4) a small equine which in Pleistocene times occurred in Algiers, to which M. Thomas gave the name *E. asinus atlanticus*. M. Boule regarded the last two as closely related, and as probably the direct ancestors of the zebras now living in South Africa. The Italian, French, and English deposits have also yielded cannon bones—metacarpals and metatarsals—as slender as those of the fine-boned desert Arabs, but not so slender as the cannon bones of the Onager and other wild asses of Asia. From inquiries extending over some years, Prof. Ewart had ascertained that there were small horses in the Roman Fort at Newstead, near Melrose, with molars of the same type as those from Oreston, and with cannon bones as slender as the fossil ones from the Valley of the Arno, Auvergne, and Kent's Cave, Torquay. Further, in a six-year-old Shetland pony of the Celtic type he had recently noticed that the first upper molars, in size as well as in the enamel foldings, were practically identical with the small first Oreston molar in the British Museum. He was of the opinion that the teeth said by Owen to belong to a fossil ass or zebra really belonged to a small race of horse, from which have in part descended the modern Exmoor, Welsh, Shetland, and other ponies of the Celtic type. To this small, true horse, which in Pleistocene times probably ranged from Algiers to the south of England, he had given the name *Equus agilis*—the more appropriate name *gracilis* not being available. Bearing in mind that several of the zebra hybrids which he had bred some years ago seemed, at least in their markings, to reproduce ancestral types, he decided to try to restore the small race which lived in the south of England along with the mammoth. By blending all the available Occidental and Oriental breeds, Prof. Ewart had now obtained several ponies which probably in make, disposition, and colour, as well as in limbs and teeth, fairly accurately reproduced the small, slender-limbed species hunted and sketched or sculptured by our Palæolithic ancestors. The pony which probably restores most accurately the small, fine-boned prehistoric race has a fine head, slender limbs and small hoofs, a mane which instead of clinging to the neck arches to one side, a well set-on tail, and only two of the eight callosities usually found in horses, *i.e.* the four ergots and the hind chestnuts are absent. This pony, like the other forty crosses bred, cannot be described as "more or less striped"—there is only a narrow dorsal band and a faint shoulder stripe—and hence lends no support to the view that in prehistoric times all the wild horses were at least as richly decorated as the recently extinguished quagga, or to M. Boule's view that the small horse which in Pleistocene times inhabited the south of France and North Africa is the direct ancestor of the zebras now living in South Africa. Though this hybrid pony is, like the wild horse of Mongolia, of a yellow dun colour, and is a mixture of seven more or less well-marked breeds, namely, Connemara, Welsh, Hackney, Iceland, Hebridean, Shetland, and Arab, it excels in make, action, and intelligence all the other ponies of a like age—an indication perhaps that, notwithstanding its mixed origin, it possesses the traits of an ancient wild race.

PARIS.

Academy of Sciences, January 10.—M. Émile Picard in the chair.—H. **Deslandres**: The magnetic storm of September 25, 1909, and the connected solar phenomena. A verification of some theories proposed. A discussion of the various theories of the influence of the sun on the earth. The author regards the theory of kathode radiation put forward by himself and by Birkeland as offering a sufficient explanation of the observed facts. It explains the delay of forty-five hours of the magnetic storm with respect to the passage of the active spot across the central meridian, and is connected with the author's theory of nebulæ.—J. **Carpentier**: Remarks on a frequency meter constructed from the designs of Commandant Ferrié, and also on a small precision balance constructed by M. Collot. The weights, from 50 grams to a decigram, are introduced on the pans by pressing buttons external to the balance case; the smaller weights are read by a microscope as deviations of the pointer. The balance works at constant load—100 grams—and by substitution, and is very rapid in its indications.—C. **Guichard**: The surfaces of total constant curvature which correspond to singular systems of any order.—C. **Russyan**: The theorem of W. Stekloff (the generalised theorem of Jacobi) and generalised formulæ of contact transformation.—Henri **Lebesgue**: The integral of Stieltjes and linear functional operations.—J. **Le Roux**: Definite quadratic forms with an infinity of variables.—E. **Jouguet**: The impossibility of certain waves of shock and combustion.—E. **Estanave**: Images changing from two or three points of view on the autostereoscopic plate.—Edm. **van Aubel**: The production of ozone under the influence of ultra-violet light. The production of ozone by the action of ultra-violet light, first observed by Lenard, has been confirmed by other observers. On the other hand, H. Bordier and T. Nogier have recently described experiments leading to the contrary conclusion. The experiments detailed in the present paper confirm Lenard's experiments.—F. **Ducelliez**: The study of some alloys of cobalt from the point of view of their electromotive forces. Curves are given for the experimental measurements with alloys of cobalt with tin, antimony, bismuth, lead, and copper.—A. **Besson** and L. **Fournier**: A new chloride of phosphorus. No chloride of phosphorus corresponding to the hydride P_2H_4 and the iodide P_2I_4 has hitherto been described. This chloride, P_2Cl_4, is produced by the action of the silent electric discharge on a mixture of hydrogen with the vapour of phosphorus trichloride. The new chloride forms a colourless, oily liquid, solidifying at $-28°$ C., and distilling with slight decomposition at $95°$ C. under a pressure of 20 mm. It absorbs oxygen rapidly from the air, and sometimes catches fire spontaneously. Attempts to isolate the corresponding bromide were unsuccessful.—Marcel **Delépine**: The solution of platinum in sulphuric acid, and on the products of this reaction. The presence of oxygen is not necessary to the reaction between platinum and sulphuric acid, as has been assumed by M. Quennessen, since solution takes place in a stream of carbon dioxide, air, oxygen, or carbon dioxide mixed with sulphur dioxide.—Pierre **Jolibois**: Two new phosphides of nickel. These compounds were obtained by heating a nickel-tin alloy in sealed tubes with phosphorus. The composition of the phosphides agreed with the formulæ NiP_2 and NiP_3.—E. **Cornec**: The formula of hypophosphoric acid. A cryoscopic study of aqueous solutions of the acid and the potassium salt. The double formula $H_4P_2O_6$ agrees best with the facts observed.—J. B. **Senderens**: The catalytic preparation of the aromatic ketones. The catalytic action of thoria at $460°$ C. upon a mixture of benzoic and a fatty acid gives a mixture of the symmetrical fatty ketone and the mixed fatty aromatic ketone, no benzophenone, apparently, being formed. The method has been successfully applied to the preparation of ketones of the general formula C_6H_5—CO—R, in which R was methyl, ethyl, normal and isopropyl, and isobutyl.—M. **Lespieau**: Methylacetenylcarbinol.—Em. **Bourquelot** and M. **Bridel**: The presence of gentiopicrin in *Chlora perfoliata*. Details are given of the methods employed for isolating this glucoside in the pure state.—H. **Bierry**: Researches on the digestion of inulin. It is found that various animals are capable of digesting inulin, but they employ for this digestion different physiological agents. In the higher animals, the transformation of the inulin takes place in the stomach, and is due to the hydrochloric acid of the gastric juice; in molluscs a ferment is secreted which is capable of hydrolysing the inulin to levulose.—J. **Sarthou**: The presence in cow's milk of a catalase and an anæroxydase. The statement of MM. Bordas and Touplain that the insoluble casein of milk is capable of decomposing hydrogen peroxide is denied, and experiments detailed which tend to show that this action is due to a mixture of a physiological catalase and a bacterial catalase.—Louis **Roule**: The structure of the epidermal protuberances of certain Amphibia and their morphological affinities with the nails.—J. **Nageotte**: A new formation of the myeline layer.—J. **Mawas**: The structure of the ganglion nerve cells of the amyelinic cord of the Cyclostomes.—A. **Contamin**: The immunisation against cancer of mice inoculated with tumours modified by the X-rays.—L. **Bull**: The mechanics of insect flight.—C. **Levaditi** and K. **Landsteiner**: Researches on experimental infantile paralysis. The preventive inoculation of animals by means of the dried spinal cord is possible.—A. **Thiroux** and W. **Dufougeré**: A new spirilla from *Cercopithecus patas*. This organism resembles in its morphological characters the *Spirillum duttoni* of tick fever, from which, however, it is distinct. The name *Spirillum pitheci* is proposed.—L. **Cayeux**: The prolongation of the Silurian oolitic iron deposits under the Paris basin.—E. **de Martonne**: The mechanical theory of glacial erosion.—Alfred **Angot**: The value of the magnetic elements at the Val-Joyeux Observatory on January 1, 1910.—E. **Esclangon**: The intensity of gravity and its anomalies at Bordeaux and neighbourhood.—E. **Péroux**: The mineral contents and chemical analysis of the water from the artesian wells of Maisons-Laffitte.—André **Brochet**: New determinations of the radio-activity of the thermal springs of Plombières. These springs are strongly radio-active, this effect being due to the radium emanation.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 20.

ROYAL SOCIETY, at 4.30.—Further Observations on the Pathology of Gastric Ulcer (Progress Report): Dr. C. Bolton.—(1) The Velocity of Reaction in the "Absorption" of Specific Agglutinins by Bacteria, and in the "Adsorption" of Agglutinins, Trypsins, and Sulphuric Acid by Animal Charcoal; (2) On the Absorption of Agglutinin by Bacteria, and the Application of Physico-chemical Laws thereto: Dr. Georges Dreyer and J. Sholto Douglas.—Observations on the Rate of Action of Drugs (Alcohol, Chloroform, Quinine, Aconitine) upon Muscle as a Function of Temperature: Dr. V. H. Veley, F.R.S., and Dr. A. D. Waller, F.R.S.—An Examination of the Physical and Physiological Properties of Tetrachlorethane and Trichlorethylene: Dr. V. H. Veley, F.R.S.—The Action of Antimony Compounds in Trypanosomiasis in Rats: J. D. Thomson and Prof. A. R. Cushny, F.R.S.—"Amakebe" (a Disease of Calves in Uganda): Colonel Sir David Bruce, F.R.S., Captains A. E. Hamerton and H. R. Bateman, R.A.M.C., and Capt. F. P. Mackie, I.M.S.—On Scandium: Sir William Crookes, For.Sec.R.S.

ROYAL INSTITUTION, at 3.—Assyriology: Rev. C. H. W. Johns.

LINNEAN SOCIETY, at 8.—Discussion on the Origin of Vertebrates: Dr. Gaskell, Dr. Gadow, Mr. Goodrich, Prof. Starling, Prof. MacBride, Dr. Smith Woodward, Prof. Dendy.

INSTITUTION OF MINING AND METALLURGY, at 8.—Copper Leaching Plant in the Ural Mountains: A. L. Simon (*Adjourned discussion.*)—Some Analyses of Copper Blast Furnace Slags and Determination of their Melting Points: A. T. French.—The Detection of Minute Traces of Gold in Country Rock: A. R. Andrew.—Errors due to the Presence of Potassium Iodide in testing Cyanide Solutions for Protective Alkalinity: B. Collingridge.

FRIDAY, JANUARY 21.

ROYAL INSTITUTION, at 9.—Light Reactions at Low Temperatures: Sir James Dewar, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Ninth Report to the Alloys Research Committee: On the Properties of some Alloys of Copper, Aluminium, and Manganese (with an Appendix on the Corrosion of Alloys of Copper and Aluminium when exposed to the Sea): Dr. W. Rosenhain and F. C. A. H. Lantsberry.

PHYSICAL SOCIETY, at 5.—Saturation Specific Heats, &c., with van der Waals' and Clausius' Characteristics: R. E. Baynes.—The Polarisation of Dielectrics in a Steady Field of Force: Prof. W. M. Thornton.—On the Use of Mutual Inductometers: Albert Campbell.

MONDAY, JANUARY 24.

ROYAL SOCIETY OF ARTS, at 8.—Textile Ornamentation: A. S. Cole.

VICTORIA INSTITUTE, at 4.30.—The Attitude of Science towards Miracles (being the Gunning Prize Essay, 1909): Prof. H. Langhorne Orchard.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Travels in Northern Arabia: D. Carruthers.

TUESDAY, JANUARY 25.

ROYAL INSTITUTION, at 3.—The Cultivation of the Sea: Prof. W. A. Herdman, F.R.S.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Annual General Meeting.—Presidential Address: The Influence of Environment on Man: Prof. W. Ridgeway.

MINERALOGICAL SOCIETY, at 5.30.—On a Group of Minerals formed by the Combustion of Pyritous Shales: S. J. Shand.—A Crystal-holder for Measuring Large Specimens: W. J. Lewis.—Some Observations on Pleochroism: T. Crook.—Notes on the Weight of the "Cullinan" Diamond and on the Value of the Carat-weight: L. J. Spencer.—On a Basalt from Rathjordan, Co. Limerick: G. T. Prior.—On a Fluo-arsenate from the Indian Manganese Deposits: G. F. H. Smith and G. T. Prior.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Reconstruction of the Tyne North Pier (*Discussion*): I. Collingwood Barling.

WEDNESDAY, JANUARY 26.

ROYAL SOCIETY OF ARTS, at 8.—Goldsmiths' and Silversmiths' Work: O. Ramsden.

GEOLOGICAL SOCIETY, at 8.—On a Skull of Megalosaurus from the Great Oolite of Minchinhampton: Dr. A. S. Woodward.—Problems of Ore-deposition in the Lead- and Zinc-veins of Great Britain: A. M. Finlayson.—On the Vertebrate Fauna found in the Cave-earth at Dog Holes, Warton Crag (Lancashire): J. W. Jackson.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, JANUARY 27.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Note on Carbon Monosulphide: Sir James Dewar, F.R.S., and Dr. H. O. Jones.—Long-period Determination of the Rate of Production of Helium from Radium: Sir James Dewar, F.R.S.—On the Extinction of Colour by Reduction of Luminosity: Sir William de W. Abney, K.C.B., F.R.S.—The Initial Accelerated Motion of Electrified Systems of Finite Extent, and the Reaction produced by the Resulting Radiation: George W. Walker.—On the Nature of the Magnetokathodic Rays: H. Thirkill.

ROYAL INSTITUTION, at 3.—Assyriology: Rev. C. H. W. Johns.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Equitable Charges for Tramway Supply: H. E. Yerbury.

FRIDAY, JANUARY 28.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Some Uses of Mechanical Power in Engineering Construction: H. F. Donaldson.

SATURDAY, JANUARY 29.

ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford), at 6.—Trawl Fishing in the North Sea: S. H. Goodchild.

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