THURSDAY, MARCH 8, 1900.

EGYPTIAN AND BABYLONIAN RELIGION AND MYTHOLOGY.

Books on Egypt and Chaldaea. Egyptian Ideas of the Future Life; Egyptian Magic. By E. A. Wallis Budge, M.A., Litt.D., D.Lit. 2 vols.

Babylonian Religion and Mythology. By L. W. King, M.A., F.S.A. 1 vol. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1899.)

THE delightful certainty which characterises the youth of an individual not infrequently finds its analogue in the initial phases of a science. At the outset assertion is dogmatic inversely to the evidence, and the flimsiest figments are made to serve as the basis of the widest generalisations. Maturity brings with it a curious restriction of certitude, but for this there is a compensation in the knowledge that for the faith which we do hold there is an adequate reason. Thus it has long been the custom to regard the religion of ancient Egypt as a tissue of the grossest idolatry, and this amongst persons who were not, in general, ill-informed. To such a view the education of the public school and the university has largely contributed, and those who were contented to mould their opinions upon classic authorities would be apt to remember nothing more than Juvenal's telling gibes, which practically epitomise the creed as that of the ape and onion. Whatever the poet's personal views may have been, those which the exigencies of his satire led him to express are far removed from the truth or, at least, they state it so partially as to be wholly misleading; and it may come as a surprise to many to learn the magnitude of the libel. As a matter of fact, the ideas and beliefs of the Egyptians concerning God closely approximated to those of the Hebrews, and of the Muhammadans at a later period; and they arrived at conceptions of man's immortality for which we look in vain in the Jewish record, and which we only re-encounter in the teaching of the Christian churches.

Dr. Budge emphasises the fact that an exalted monotheism was the basis of the theology and religion of ancient Egypt, and that it persisted throughout its historic periods with a tendency ever increasingly assertive. God was one, self-existent, immortal, invisible, eternal, omniscient, almighty and inscrutable; the creator of the heavens, the earth, and of all things visible and invisible. But long as the period was during which this noble creed was held, there was unquestionably a time prior to its evolution when a more primitive conception prevailed, and when the beliefs of the people were probably similar to those of existing savages: when family and tribal gods were worshipped whose characteristics were those of their adorers, and whom a victory or a defeat raised to supremacy or relegated to oblivion. It has been observed that three main elements may be recognised in the Egyptian religion. A solar monotheism, or a god specially manifested in the sun; the worship of the regenerating powers of nature or the adoration of ithyphallic deities; and an anthropomorphic divinity; but the sequence in time of these phases of faith is doubtful, and they ultimately became intermingled in a most bewildering manner. Where such uncertainty exists we must rest satisfied with a suspension of judgment; but it may be reasonable to assume that the less exalted views were formulated before those of a higher type; that the earlier notions acquired from their antiquity a sanctity which led to their retention; and that ecclesiastical conservatism was responsible for that grotesque admixture of puerile superstitions, both in faith and practice, which disfigured the higher faith to such an extent as to cause strangers to regard it as the essential element of that purer religion by which it had been supplanted. This curious grafting of views has an apt illustration in the picture symbol for the supreme being, who is figured by a stone axe-head in a wooden handle, a reminiscence of the time when their god was but a magnified chief, and when the wielder of the biggest war-axe being the person of prime consideration, an image of the weapon was a recognised emblem of power and sovereignty Apart from these survivals, the very piety of the worshippers served to enhance the number of the gods, for the sun-god, himself the type and symbol of the supreme deity, found his every form, phase and attribute deified, until so strangely complex a pantheon was set up that the protogod was almost whelmed by the sanctifications of himself.

In spite of this seeming multiplication of entities, the unity of God is constantly reiterated; and if, as may well have been, this truth was hidden from the perception of the vulgar crowd, we may believe that to the educated layman, as well as to the priest, it was an ever-present fact. The pure and unthinkable spirit which formed the subject of their devout adoration dwelt originally in the darkly-shrouded water of the primeval abyss. Thence, by uttering his own name, he evolved himself; whilst from the void, the world sprang into existence, after the type which was pre-existent in the divine mind. Following this creative act was the production of the germ from which emerged that embodiment of the power of God, the holy Ra, whose attributes were subsequently annexed by that great Osiris, who for ages was the ensample and comfort of aspirants to immortality. It is curious that no comprehensive account of the career of Osiris has been found in the Egyptian records, and that we depend upon Plutarch for a connected history. This, as it is confirmed by various Egyptian inscriptions, may be outlined as follows:—Osiris was the offspring of Nut by Seb, and was the husband of his sister Isis. As King of Egypt, he advanced civilisation; taught the art of agriculture; and exhorted men to worship the gods, both in his own and other lands. On his return from foreign proselytising, he was slain by the machinations of Set, who repossessed himself of the body, after it had been obtained by Isis, and tore it to pieces. The fragments, with a single exception, were recovered and buried by Isis, who instituted a special festival in honour of the missing portion. By divine assistance Isis obtained such a revivification of Osiris that, by him, she became the mother of Horus, who was, later, his father's avenger. Of the exact position which in prehistoric days was occupied by Osiris we are ignorant; but, in all later times, he was regarded as a being of divine origin, who was killed and mutilated by

the powers of evil, and who rose again to become King of the Underworld and judge of the dead. He represented the idea of one who, though a god, had been a man who had suffered and died, and who was, therefore, in full sympathy with human beings in their own time of trial and death. As his flesh had not seen corruption, so was he the cause of mortals being born again, and the righteous who followed his ensample might, with the help of the gods, secure a resurrection to everlasting life, and dwell with him in his kingdom.

In this way Osiris, from being the example of a man raised from the dead, became himself the cause of the resurrection and the bestower of eternal life, and it is needless to say that his ever-increasing popularity finally raised him to the position of the quasi-national God. He gradually assumed the attributes of the cosmic deities and even of the creator; and thus making himself his father's equal, he reigned beside him in Heaven as the divine source of all things. It is sufficiently evident that the growth of such conceptions must have been gradual, and that prior to their formulation the condition of the disembodied spirit must have been largely problematic. It was then, no doubt, regarded as a spook which it was as well to banish from the precincts of the living; and those mutilations and cremations of corpses which were originally practised may have been intended to coerce the spirit into an abandonment of his old habitation. With the belief in a resurrection a new order of ideas arose, and, far from a desire to destroy the body, every means was sought for its preservation. The outcome of the new dogma was that wonderful system of mummification with which we are familiar, but the adoption of which, in view of the strongly expressed declaration that immortality was confined to the spiritual body, is somewhat inexplicable. It may be that the primary conception of the resurrection was that of the physical body, and that the spiritualisation of the tenet was a subsequent modification; in which case the later retention of the practice would be due to the ever observable reluctance of man to change the procedures associated with the crises of his existence. Another explanation may be found in the fact that the spiritual body derived its existence from the physical body through the prayers and ceremonies of the funeral rites. There are various pictures representing the departed soul as hovering in proximity to the mummied corpse, of which, possibly, it could but gradually acquire the characteristics. Were that the case, the necessity for a prolonged retention intact of the senseless clay is intelligible in order to afford ample time for the intended assimilation whereby the mortal put on immortality. Be this as it may, by whatever process the spiritual body acquired its existence, it was called upon to answer for the deeds done in the flesh: the heart, as the seat of being, was literally weighed in the balance, and woe to its possessor were it found wanting. Then the deceased had to declare himself innocent of forty-two specific transgressions contained in a catalogue which is so skilfully compiled to include every possible wickedness, that it must have been very difficult to sin outside it. Either, then, the gods failed to verify their facts, or, unless they differed considerably from the men and women of to-day, the number of the Egyptian elect must have been infinitesimal. The final admittance to Elysium was further hindered by a series of perplexing interrogatories—floor and threshold—hasp and socket each in turn propounded its riddle to the aspiring soul; an ordeal apparently purposeless until it is understood that it was the business of the priesthood to furnish the replies which were needed to pass the purified spirit to the presence of that Osiris with whom he had at last become identified.

When we find the ecclesiastical body purveying such wares for the spiritual well-being of their flock, it is evident that the line of demarcation between religion and magic is faint. Indeed, as one reads the documents cited by Dr. Budge, it is by no means easy to determine the category to which certain practices and invocations should be relegated. In a sense the whole religion was so theurgic that it might pass for a sublimated magic; whilst much of what is classed as magic consisted in such invocations of divine beings, and aspirations for assimilation to them, as to contain the essence of genuine religion. It may be taken that the fundamental doctrine of magic is contained in the formula, "whatever is above is below, and whatever is below is above." The idea being that all existing things are created after divine prototypes, and that by an accurate perception of the one a knowledge of the other is obtainable. The germ of such an idea evidently existed in Egypt, the Supreme God having produced the universe in accordance with his previous mental conception. The premises being admitted they might serve either as the means by which a partial comprehension of the creator was obtainable, and as inciting the student to thankfulness and adoration; or they might place in his hands a means not only of invoking the gods, but of compelling them to his will. It must always be borne in mind that ideas, whether religious or not, are not the outcome of unreasoning invention, but are the result of a certain sequence of thought, however wanting it may be in logical acumen. The association of a certain evil with a certain precursory series of facts may have been arrived at on the post-hoc propter-hoc principle; but that this is so only proves the insufficiency and inadequacy of the observations upon which the association was reached, and not that it was arbitrarily devised. In many cases the mental position from which a belief or a custom was reached is so alien to our own that we are unable to reconstruct the train of thought by which it was arrived at; but in some cases we have been provided with a key to the mystery, and that is especially the case where names are in question. A spirit appearing before the gods had to be known and named by them. Nameless, he was non-existent, and consequently we find that, to the Egyptian, the name was as much a part of a man's being as his soul. Just as possession of the soul would place the entire individual in the possessor's power, so the name of god or devil gave a control which made the spirit your humble servant. The names of beings or things were words of power to conjure with, and, as has been stated, it was by the utterance of his own name that God brought all things into existence. It was but doing on a supreme scale what man on a lesser might perform; and when the potency of the uttered word was admitted, the transition to the efficacy of the written charm and

the engraved talisman was a mere question of time and of a certain subtlety of reasoning. From an existent sympathy between words and things a belief in an equivalent interrelation betwixt objects might arise, either from a fancied resemblance of nomenclature or by an analogous train of thought which classed together things which had some real or fancied resemblance, a process of which the mandragora of later legends is an instance. From this system of affinities, bounded only by the imaginative powers of the sorcerer, the weaving of the most complex web of enchantment was inevitable. In Egypt the system was prolific, and bore as its fruit that crop of magical figures, pictures, spells, and ceremonies, with the attendant beliefs in lucky and unlucky days, dreams, demoniacal possessions, and astrological lore, with which the learned doctor has filled his pages to the delight of the occultist.

In the study of the Babylonian religion and mythology which is presented to us by Mr. King, we find a less exalted view of divine beings than that reached in Egypt, the beliefs of the Babylonians, in such matters, having received a tincture from their predecessors, the Sumerians, which was never wholly eradicated. Of the creed thus evolved, documentary evidence older than the seventh century B.C. is wanting, but this source of information is supplemented by the recorded beliefs of the Assyrians who were themselves colonists from Babylonia. Here the gods were many, a catalogue of 1800 names failing to furnish a complete enumeration, a heterogeneous company essentially human in their attributes, who were born, caroused, loved, fought, and even died. In later historical periods the chief deities acquired definite characteristic personalities, but they were only in degree superior to their worshippers, who never reached the conception of a Supreme Being essentially different to themselves. The gods, who were personifications of the forces of nature, had their cults curiously relegated to special centres, being localised in different cities, the fortunes of which they followed. The great triad of Anu, Bel and Ea, the respective deities of heaven, earth and the abyss of waters, headed the company of the gods; with the subsidiary trinity of Sin, the moon-god, his son Shamash the sun-god, and Rammān, god of the atmosphere; but the most prominent deity was Marduk, the tutelary god of Babylon, who, as that city rose into importance, became identified with Bel, and was established as the intercessor for mankind. Scant justice was accorded the ladies, the goddesses being but faint reflexes of their husbands, with the exception of Ishtar, who occupied a position of commanding importance in her dual aspects of the patroness of love and war. No doubt the heavenly host was influenced by the peculiar cosmogony which obtained. It was thought that from out the waters which, in the darkness of chaos, alone at first existed, abnormal creatures sprang. Over this monstrous brood the woman-dragon Tiāmat was supreme, until, after creating the gods, she rose in revolt against them. She was vanquished and slain by the divine champion Marduk, who employed the fragments of her body to fashion the earth and heaven. The portion used to make the earth he shaped as an inverted bowl surmounted by the remainder of the corpse bent into the hollow hemispherical vault of heaven, and both resting on the waters of that great deep, from which all things had their origin. Above the firmament was a celestial ocean, and beyond that the innermost heaven to which the gods retired when weary of their earthly abodes and the immediate conduct of human affairs.

Beneath the earth was the seven-walled house of the dead in the "Land of no Return." Here no distinction was made between the good and the bad, all being alike condemned to the same joyless existence. The gloom which pervaded the tomb may have originated in the rapidity of decomposition and decay in the moist alluvial soil of Mesopotamia, and the elaborate burial rites which were observed had no further object than to prevent the wanderings of the earth-bound shade, who would haunt those who neglected to secure him a safe passage to Hades.

Whilst this and other passages scattered through the text will give the student of folk-lore and demonology much food for thought, the chief interest of the work naturally centres in the exposition of the resemblances which exist between the Babylonian myths and the Jewish traditions recorded in the Bible. Mr. King has directed attention to the legends of the Great Dragon, the Creation, and the Deluge, and shows that both nations derived their narratives from a common source, or that, at any rate, the Hebrews' indebtedness to the Babylonians was long antecedent to the period of the captivity. It is a matter for regret that the limits of this notice forbid more than an allusion to this section of the volume, which is likely to be that most generally attractive. In the succeeding portion is recited the poem of Gilgamesh, in which are recounted his exploits and those of his semi-divine friend Ea-bani. This story has no Biblical equivalent, unless we see in Ea-bani, who "was clothed with long hair like a woman," was of stupendous strength, and became a victim to the wiles of the woman Ukhat, the analogue of Samson and Delilah. Such resemblances must necessarily arise, and to insist upon too close an identification may be unwise; but, in leaving such speculations, we pass to what is of more human interest, the personal relations which existed between the Babylonian and his gods. Here we find that to each man, from his birth, a god and goddess were allotted as guardians and monitors. They departed from him if he transgressed, and when they so withdrew, priestly intervention was necessary to secure a return of their favour. At first mere defects of ritual observance or the utterance of ill-omened words were the sole causes of divine estrangement; but as the mental conceptions of the people were elevated, injustice to their fellows and sins against their neighbours were regarded as constituting equally valid grounds for the wrath of the gods. And so in process of time it came to pass that upon a foundation of much apparent absurdity, the good sense of the Babylonians erected a working code of morality which an existing tablet cataloguing acts that were regarded as sins shows to have been little inferior to that of the Hebrews.

It is impossible within the necessary limits to do fitting justice to the contents of these most interesting volumes, and the care with which the great mass of facts which they contain has been condensed defies any attempt to reduce them to a précis. That they fill an existing blank in the text-books on comparative religions is obvious, and

their careful documentation cannot fail to convince the reader that, in following the authors through the mazes of Egyptian and Babylonian belief and ceremonial observance, he has no uncertain guides. There will be few who will not learn from these volumes much detail of which they were previously ignorant, and many will derive from them their first clear conception of what was really believed in ancient Babylonia and of the sublime grandeur of that faith which during so many centuries was the spiritual stay and solace of the Egyptians.

FRANK REDE FOWKE.

HUXLEY'S SCIENTIFIC MEMOIRS.

The Scientific Memoirs of Thomas Henry Huxley. Edited by Prof. Sir Michael Foster, K.C.B., M.A., LL.D., F.R.S., and by Prof. E. Ray Lankester, M.A., LL.D., F.R.S. In Four Volumes. Vol. II. With Portrait. Pp. xi + 612. (London: Macmillan and Co., Ltd.)

THE second volume of this valuable series will be welcomed by a large class of readers, and not alone by those who are professed biologists. The thirty-seven memoirs here collected together for the first time in one volume were published at dates ranging from 1857 to 1864, and, therefore, cover a period of strife and ferment which originated within the scientific world, but soon spread beyond it, that, namely, caused by the publication of Darwin's "Origin of Species" in 1859.

Naturally, we find amongst the writings, at this period, of one of the foremost champions of Darwinism, many memoirs devoted either to discussion of the problem of evolution as a whole, or to threshing out some special point in the evidence for or against the theory and its applications. Such papers will always possess an interest, even if only a historical one. Here we have, for instance, Huxley's famous controversy with Owen as to the alleged constancy of the "posterior horn of the lateral ventricle" and the "hippocampus minor" as characters distinguishing absolutely the brain of man from that of the ape, and of sufficient importance to rank man as a distinct sub-class of the mammalia. It is difficult to imagine any naturalist of eminence at the present day advancing such conclusions, even granting the correctness of the premises, which, as a matter of fact, Huxley was able to impugn without difficulty. Here, again, we find the well-known controversy as to whether the human remains from the Neanderthal were those of an ape-like man or of a "rickety Mongolian Cossack." And before leaving the subject of Darwinism, we may draw attention to Huxley's eloquent and impassioned appeal, in a lecture, "On Species, Races and their Origin," delivered before the Royal Institution, for consideration of the facts of the case without prejudice. In his peroration the clerical and other opponents of the progress of physical science are likened to "little Canutes of the hour, enthroned in solemn state," who bid the great wave to stay, but who, when forced to fly, learn no lesson of humility, and pitching their tents at what seems a safe distance, repeat their folly; and, in conclusion, he calls upon the people of England to cherish and venerate science. "Listen to those who would silence and crush her, and I fear our children will see the glory of England vanishing like Arthur in the mist." At a time when colleges could be named in our great Universities whose authorities would prefer a "football blue" to a "research student," we may ask ourselves if we are not beginning to realise this prophecy.

It is not possible within the limits of a review to do more than indicate the many papers of interest collected in this volume, some of which laid the foundations of our knowledge, or marked an epoch in its advance, in not a few directions. Of great merit, but of interest to a more limited circle, are the numerous treatises upon fossil types, contributed to various geological periodicals; or anatomical memoirs, of which that upon the Nautilus may be taken as an example. Of more general interest are the two classical memoirs, "On the Agamic Reproduction and Morphology of Aphis," and "On the Anatomy and Development of Pyrosoma," in which Huxley made great additions to our knowledge, both of the theory and of the facts, of non-sexual processes of reproduction in both forms. From Pyrosoma he was led on to a discussion of the significance of the germinal vesicle of the ovum, which also forms the subject of a Royal Institution lecture deserving more than a passing notice.

At the present day it may be safely asserted that though much remains to be investigated and elucidated, yet a number of fundamental facts have been generally established with regard to the question of the nature of the sexual elements, and the process of fertilisation, in animals and plants. No instructed person now doubts that the ovum, whatever its size or peculiarities in a given species, represents a single cell set free from a many-celled organism, and that the germinal vesicle is the cell nucleus, which, after certain processes of maturation, unites in the process of fertilisation with the nucleus of the male cell or spermatozoon to form the so-called segmentation nucleus, the ancestor by repeated divisions of all the nuclei in the body of the future embryo. These are facts which now are taught to every student of biology in his first term, but in the early sixties it was not so. The details of fertilisation were unknown, except in so far that both ovum and spermatozoon were concerned in it, and the true nature of these two elements, in the light of the cell theory, was not understood. Many authorities believed that the germinal vesicle of the ovum and its contents disappeared, and had no direct connection with the cells of the blastoderm or future embryo. Huxley, on the contrary, was on the side of those who held the more correct view, that the cells and nuclei of the blastoderm stand in genetic relation to the germinal vesicle. His observations were, however, in so far erroneous, in that he believed he had seen in Pyrosoma the vitellus of the ovum disappear, and the cells of the blastoderm arising within the germinal vesicle.

In judging a mistake of this kind, the modern biologist will remember, in the first place, that the present state of our knowledge with regard to these matters has been attained by the gradual perfection of a technique more complicated than French cookery, and that to investigate or demonstrate these now well-known facts, a laboratory stocked with reagents and aniline dyes, with complicated machines for section cutting and other apparatus, is required. In the second place he will note, perhaps

with astonishment, that Huxley's observations upon Pyrosoma were "conducted upon thin sections (that is to say, cut by hand with a razor, and not with a pair of scissors) of a spirit specimen, rendered clear by glycerine."

When all this is borne in mind, we can but admire the accuracy of the observations, taken as a whole, which Huxley was able to make upon the anatomy and development of this remarkable form of life; while any impulse we may feel to criticise an error with regard to finer points of cytological detail will be checked by the thought that if, in the short space of forty years, biology can make such progress in the investigation of the most mysterious of vital processes, what judgments may the future not have in store for much of our work at the present day, even within the lifetime of many of us!

We have said enough, we hope, to prove how much interesting reading of the most varied kind is furnished by the collected works of one of our greatest scientific men, and we feel sure that many will look forward with pleasurable anticipation to the continuance and completion of this series. E. A. M.

SCENERY AND GEOLOGY.

The Scientific Study of Scenery. By John E. Marr, M.A., F.R.S. Pp. xi + 368. (London: Methuen and Co., 1900.)

SO much has been done within the last thirty years in all parts of the world, and especially in America, to discover and interpret the varied forms of earth-sculpture, that the knowledge required to be summarised. Scientific surveys and explorations, the facilities for travel, and the use of the camera have largely contributed towards the accumulation of facts. One result, and by no means the most satisfactory one, is the increase of technical terms, for which our American brethren are largely responsible. To remember what is the Uinta type of mountain folding; what is meant by consequent, subsequent and obsequent streams, by inconsequent drainage and corrasion; and what is the difference between clouds of radiation, of inversion, of interfret, and of inclination, may tax the memory and patience of any one who is not constantly engaged in teaching. Here Mr. Marr comes to the rescue, describing and explaining in clear language all the leading types of scenery, and many of the minor and no less interesting features connected with it. He discusses the origin of hill and dale, of peneplain and nunatak, butte and zeuge; and, moreover, he gives in his work an index which will enable us to dispel our ignorance or refresh our memories when, as so often happens, we come across an unfamiliar or forgotten term. There was need for this concise handbook on the scientific study of scenery.

The author makes a praiseworthy attempt to please two classes of readers—the student and the "general reader." That his work will be appreciated by the student we are fully persuaded. That the general reader will steadily puruse the volume must depend upon whether he or she reads for the sake of solid instruction.

The author's brief introduction is fascinating, but we are plunged in the next chapter into "three envelopes," the lithosphere, hydrosphere and atmosphere, and into a consideration of anticlines, synclines and monoclines, and planes of foliation, cleavage and faulting: subjects necessary for the proper understanding of various types of scenery, but not readily dealt with in pleasing language. Here and there throughout his book the author enters into a little more detail than appears to be required to explain the relation between rock-structure and rock-texture and scenery; and the general reader may find it difficult to distinguish between the "Normal Fault" and the "Monoclinal Fault" figured on p. 66. When, however, the author speaks of his work as an "Introductory Treatise on Geomorphology," we feel not only that he intends it mainly for serious study, but that he has a very decided personal regard for technical terms. He shows how dependent the scenery is on the structure of the earth's crust, on the sculpturing agents, and on the character of the climate. The colours of the sky, the water and the rocks, the forms of cloud, and the influence of vegetation come in for appropriate notice in different parts of the volume.

Continents and ocean-basins, crust-waves and speculations on lines of uplift are duly considered, and so also are mountains and valleys, escarpments, volcanoes, deserts and plains, oceans and oceanic islands. The author writes with evident enthusiasm for his subject; and whenever he is free from detail, the labours of the conscientious reviewer become more pleasant. With Kingsley he can speak with eloquence of the beauties of the Fenland, and with Captain McMahon of the charms of the desert. He records his sorrow at "the mutilation of a district rich in natural beauty" by the operations of mining or quarrying, when such works are not, as was the case with the water-works of Thirlmere, "justifiable on the ground of necessity." We remember to have seen quarrying operations in the heart of the Cheddar Cliffs, perhaps the finest inland cliffs in England, and this is an instance where local rights should be compulsorily purchased at the public expense.

We are glad to find the author dealing, every now and again, with the sentimental aspects of the subject. Hugh Miller, jun., enlarged on such topics in his "Landscape Geology" (1891); while the more recreative aspects of scenery are charmingly portrayed in the Badminton volume on Mountaineering, by Mr. C. T. Dent.

The work before us is illustrated by an admirable series of plates, reproduced from photographs The High Force of Teesdale and the Screes of Wastwater are fine examples; while others, equally good, exhibit mountain structure, glaciers and lakes. The origin of lakes is varied, but the subject has given rise to much controversy among geologists—a controversy mainly concentrated on the question whether rock basins of any magnitude have been excavated by ice-action. On this subject Mr. Marr has his doubts, and he says

"that in order to prove that ice can excavate a basin, we must show, first, that the actual rock basin exists; and, secondly, that it cannot have been formed in any other way than by the erosive action of ice."

The question is one which is under investigation at the present time; but it may be observed that, in many a lake

earth-movements, dams and erosion may all have contributed towards the production of the features.

The work of frost, snow and ice, and the accounts of glacial phenomena past and present, are, like every other portion of his subject, very fully and ably dealt with by the author. The work, indeed, embodies the results of the most recent researches on all the physical features of the earth's surface; it unites the labours of the geographer and geologist; and should prove a most helpful companion to every traveller. H. B. W.

OUR BOOK SHELF.

Plant Relations: a First Book of Botany. By John Coulter, A.M., Ph.D. Pp. vii + 264. (New York: D. Appleton and Co., 1899.)

A NOTABLE tendency to be observed in many modern text-books of botany is one indicating a departure in the direction of "natural history" as distinct from the more formal, and especially the histological, methods of teaching which have been in vogue (and somewhat too exclusively so) during the last few decades. It is perhaps chiefly in American works that this change has been most prominent, and Prof. Coulter's new book forms a weighty addition to the list.

It may perhaps be open to question whether ecology, as it is now the fashion to designate what used to be called natural history, is precisely the best aspect from which to treat botany regarded as an instrument of school education. For it is impossible to escape from a certain elusive vagueness in attempting even an elementary discussion as to the nature and interaction of the factors which determine so complex a matter as the forms or the mutual adaptation of living organisms.

But whatever may be thought in the abstract, of ecology as an introduction to botany from the scholastic point of view, there can hardly be two opinions with regard to the fascinating nature of the study itself; and as Prof. Coulter remarks in the preface to his book, it may perhaps not unfairly be argued after all that "the study of the most evident life-relations of plants gives a proper conception of the place of plants in nature. . . . The large problems of ecology are constantly presented in subsequent experience, when details of structure would be forgotten." The latter sentence, however, involves an admission of principles to which many educationalists would refuse assent. Prof. Coulter's book contains a great deal more, however, than geology in the more limited sense of the term; and it may perhaps not unfairly be described as dealing with the plant primarily as a living organism, a "going concern," and one which has, moreover, to maintain the order of its going.

In fact, the author may be congratulated on having produced one of the most interesting and refreshing little text-books that have appeared in recent years, and it will well repay a perusal on the part of those whose business it is to teach as well as to learn. The dominant note all through the book is physiology, using the term in its widest sense; and, although here and there perhaps an expression might prove to be open to misconstruction, the treatment is generally accurate and lucid. The differences between spores and seeds, for example, are (p. 111) forcibly and almost epigrammatically expressed, and this is but one out of many instances which might have been cited.

The numerous illustrations, which are nearly all excellent, add materially to the value of the book, and those which portray the vegetation characteristic of the different physical conditions of life call for especial praise. Not only are they admirably reproduced, but they really do emphasise clearly the *facies* of the various kinds of plant-societies. J. B. FARMER.

Elementary Chemistry for High Schools and Academies. By Albert L. Arey, C.E. Pp. xi + 271. (New York: The Macmillan Company, 1899.)

MR. AREY has followed the syllabus of the New York State Board of Regents in selecting portions of the science of chemistry for treatment, and in deciding the order in which such subjects shall be dealt with. A notable characteristic of his book is the admirable series of questions which the author has interspersed with the view of guiding the student's inferences, and of suggesting a definite line of thought in each experiment. But the exigencies of teaching in schools where the syllabus of instruction is laid down by an outside authority has made it impossible for Mr. Arey to consistently follow out this excellent plan; for the students are expected to become familiar with substances which do not lend themselves to experimental treatment, and with principles which cannot be practically proved, at the hands of young pupils. The consequence is that two methods of presentation exist side by side. In one the student is told the properties of certain chemical bodies; while in the other the properties of the compounds have to be determined by the pupil's own observation, and are not stated in the book at all. Notwithstanding this, the volume provides a good introduction to the study of inorganic chemistry.

A Manual of Chemistry, Inorganic and Organic. By Dr. Arthur P. Luff, B.Sc., and Frederic J. M. Page, B.Sc. Pp. xvi + 541. (London: Cassell and Company, 1900.)

DR. LUFF'S "Introduction to the Study of Chemistry," which has been well known to medical students for the past eight years, has been completely revised by Mr. Page, who has also incorporated such new facts and methods as the research work of these years has made necessary. The plan of the book is of a kind which was more familiar twenty years ago. No instructions for experiments to be performed by the student himself are included, except in the short concluding section of the volume, which provides tables for the examination of chemical substances containing one metal and one acid, and includes some half-dozen pages on the preparation of a few typical compounds. The book will probably continue to be useful in assisting medical students to pass their examinations; but it is unlikely to be adopted for any other purpose. So much ground is covered in the little volume that in parts it is little more than a dictionary.

Dictionary of the Lepcha Language. Compiled by the late General G. B. Mainwaring. Revised and completed by Albert Grünwedel. Pp. xvi+552. (Printed and published by order of H.M. Secretary of State for India, 1898.)

THE preservation of the language of a dying race is a duty which ought never to be neglected. The late General Mainwaring had an intimate acquaintance with the language of the Lepchas of the Sikkim and Darjiling hills, and published a grammar of it in 1876. He also collected the materials for a dictionary, but death prevented him from completing it. To Dr. Grünwedel was entrusted the task of preparing this work for press, and he has found it a very difficult one. The whole of the manuscripts had to be rewritten and rearranged, and many new definitions had to be added. Errors and discrepancies are inseparable from a dictionary of an Indian language commenced by an Englishman, completed by a German, and printed by printers who understand neither Lepcha nor English; but they will be overlooked if the difficulties the editor has had to contend with, and the permanent value of the work, are considered.

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.]*

The Structure of the Inner Corona.

IT was my good fortune to observe the total eclipse of 1878 at the very exceptionally favoured station of Pike's Peak, at an elevation of 14,000 feet, and in the clearest air.

Having a few months earlier, on the occasion of the transit of Mercury, of May 6, been enabled to see the planet *before* it reached the sun's limb, owing to its projection on the background of the inner corona, I was greatly impressed by the brightness of the latter close to the sun, and though unable to give it more than a few seconds' visual observation during the eclipse, this was done with a five-inch achromatic, with a magnifying power of 72, which, so far as I know, gave the earliest intelligence of the extraordinary structure which obtains there.

I quote from my report addressed to the Superintendent of the United States Naval Observatory, and published in the *Annals* of the Observatory for 1876 (Appendix iii. p. 209):—

"What I saw thus momentarily was not in the least what I expected. If there were any structure in the very inner corona, it had escaped me when I had searched for it in a previous eclipse (at Jeres, in 1870). It is true that the sky was hazy on that occasion, and that on this it was exquisitely clear. Now what I saw in this brief view was a surprisingly definite filamentary structure, somewhat coarser and decidedly more sharply defined than I have ever seen filaments in the photosphere, not disposed radially, or only so in the rudest sense, sharpest and much the brightest close to the disc, fading rapidly away into invisibility at a distance of five minutes of arc or more (possibly in some cases of ten). The salient point to me was this very remarkable definiteness and precision of these forms, and this impression, made on my mind in that too brief moment, is reproduced in this sketch (*not here given*), taken from one made within ten minutes of the event. It is in no way a 'picture,' but a reproduction of the original memorandum of the first impression of the features of the (telescopic) inner corona, which were, to repeat: (1) Extraordinary sharpness of filamentary structure; (2) arrangement not radial, or only so in the rudest sense; (3) generally curved, not straight lines; (4) curved in different directions; (5) *very* bright close to the edge, and fading very rapidly,—fading out wholly at from five to ten minutes from it."

If I can trust to this memorandum of an observation which, however brief, was made under uniquely favourable circumstances, and to my own recollections, I should say that while most interesting photographs of the inner coronal structure have recently been made, yet that this feature has not yet been done justice to even in the best of them I have seen, and that it perhaps cannot be, with our present means. While trusting then that at the coming eclipse it will be a prominent subject for every party with an adequate photographic outfit, I beg to express the hope that wherever possible it may be made the subject of telescopic visual study. S. P. LANGLEY.

Smithsonian Institution, Washington, February 23.

Suggested Source of the Energy of the "Becquerel Rays."

IN view of the difficulties arising in supposing that the energy to produce the photographic, ionising and phosphorescent screen effects with the "Becquerel Rays," continuously emanates from the active substance, I would suggest that the possibility should be kept in view of the real source of the energy being found in the things themselves in which these effects are manifested.

From this point of view the emanating influence would be looked upon rather in the light of lines of force than as a wave propagation; and, indeed, up to the present we have no conclusive evidence that the effects are those of waves.

The ionising power is especially suggestive, and considered in connection with other known ionising effects through molecular distances, may well be only the case of similar action taking place over greater distances, corresponding to centres of greater molecular mass, such as the atomic weights of those up to the present observed active substances possess. The effect would then be viewed as due to what might be called a Becquerel field of force, arising it may be from some strained condition of the ether directly accompanying the existence of material molecules, or through the intermediary action of molecular chains. In this connection, as well as on account of the magnetic deflection, it would be important to know if the action takes place through a really high vacuum.

From this view the active substance need not lose in power with time, and so long as fresh unused-up material to be acted upon is brought up there need be no cessation in the effects observed.

An observation of M. and Mdme. Currie that a phosphorescent screen ceased to afford illumination after a time, although the active substance continued to effect fresh screens is in agreement with this, as well as their further observation that the exhausted screen after exposing to light is again capable of being effected. Thus some of the energy, at least if not all, is apparently to be attributed to the screen.

The effect, then, would be looked on as one of chance alignment or directive selection in a field of force; advantage, so to speak, being taken of suitable molecular movements according as they occur in the effected matter.

From this point of view there would be a close analogy with the action which takes place in a piece of soft iron in the field of a permanent magnet. The process of gradual orientation of the molecules in the iron, while it is occurring, corresponding to, say, the luminous stage in the phosphorescent screen. The final stage of magnetisation corresponds to the exhausted condition of the screen.

If these suggested views were correct we might expect from the analogy that forces should exist between the acted-on substance and the source of the "Becquerel Rays."

FRED. T. TROUTON.

Physical Laboratory, Trinity College, Dublin.

A Possible Cause of the Variability of Stars.

IN our study of nature it is sometimes advantageous to speculate as to possible causes of observed phenomena in cases where we are not yet in a position to institute an investigation which would entitle us to have no doubt as to the true cause. The cause suggested by the speculation may possibly prove to be the true cause; and if not, it is at all events likely to bear a valuable analogy as regards the laws of its operation, with the mode in which the real cause operates.

Prof. George Darwin's theory as to the origin of the moon is one of the most striking examples of such a speculation; and it was on reading it some years ago that an application of the same principles of action to account for variable stars occurred to the present writer. He now publishes the speculation because it seems to offer a satisfactory explanation of some remarkable facts recently brought to light which have attracted much attention, viz. that as many as forty stars of the Cluster Messier V., nearly one-twentieth of all the stars in the cluster, have been found to be variables possessing periodic times, light-curves, maxima of brightness, and minima of brightness, which, though not the same, do not differ much from one star to another.

As an introduction to the explanation which is about to be suggested, it will be convenient to refer to a very early experience of the writer. Potatoes used formerly to be boiled in open pots over a naked fire, and a phenomenon then presented itself, which he often watched when a boy with wonder, until at length, to his satisfaction, he perceived the very simple cause to which it is due. The water at almost equal intervals of time swelled up, and a little boiled over; it then subsided and boiled more tranquilly. These phases were repeated with surprising regularity, making the whole a definite quasi-periodic phenomenon; although upon a closer scrutiny it was found that the intervals, while nearly, were not exactly equal, neither were the recurring phases of the phenomenon accurately alike. Further experience showed that this example of quasi-periodicity is not exceptional, but one of a great body of quasi-periodic phenomena which occur in nature. With one of them we are here concerned, viz. with that which goes through its evolutions upon our sun, and manifests its approximately periodic character in the eleven-year period of sun-spot frequency.

It is obvious that the movements and other events to which sun-spots are due would only need to become a good deal more energetic to render our sun a perceptibly variable star with a period of eleven years. Now, a cause which may perhaps render them more effective is this. According as the sun or other star shrinks, its sun-spot or star-spot period will presumably undergo some change; but it is very unlikely that this change will follow the same law as that which governs the progressive shortening of the period of natural pulsation within the entire mass of the star. Accordingly, at a certain epoch in the history of the star, the two periods may approximate to one another. Thereupon the events producing star-spots are likely to acquire augmented intensity, which may render the star a variable star for a long cosmical period; in fact, until further shrinkage shall have slowly destroyed the adjustment.

Nor is it necessary that the two periods—that of star-spot frequency and that of natural pulsation within the star—shall become identical. The fluctuations in the number and size of star-spots will probably become exaggerated whenever the two periods in question become related in other simple numerical ratios. Accordingly, a star in the whole course of its life-history may at more than one stage become a variable star, although the most conspicuous fluctuation of its brightness, and that which is represented by the simplest form of light curve,[1] will only occur when the periods become equal.

In Messier V.—the great cluster in Virgo—the evidence which is published by Prof. Bailey in the *Astrophysial Journal* of last November establishes the fact that at least forty of its stars, or nearly one-twentieth part of all the stars of the cluster, differ but little from one another in brightness, and exhibit other resemblances which indicate that these stars are now very much alike in their physical condition. It is, therefore, in a considerable degree probable that at a remote epoch in the past they were so nearly in the same physical condition as to have then had pretty nearly the same brightness, the same star-spot period, and the same period of internal dynamical vibration. This amount of resemblance between so large a proportion of the stars of the cluster will not seem improbable to any one with experience of the appearances of star clusters, in many of which a conspicuous feature is the very notable proportion of the stars which are of one or of some few definite magnitudes.

If then these forty stars were originally nearly alike, they would continue so during their subsequent history. They would all shrink in the same way, they would continue at each subsequent epoch to have nearly the same star-spot period, and also to have all of them approximately the same period of natural internal pulsation; and would accordingly all arrive nearly simultaneously at that stage when these periods approximate. They would then all of them become variables, and under precisely the circumstances which have been observed, viz. with the simplest form of light curve, and with some approach towards having the same maximum of brightness, the same minimum, and the same period of fluctuation.

It has been observed above that in the successive adjustments that may arise while a star is shrinking, some may be of a kind to lead to variability with more than one minimum in each cycle, while the principal adjustment (where the two periods become the same and not merely simply related) will have only one minimum in each cycle. Instances of both are presented by known variable stars; though naturally the second case is that which has been most noticed because it is, when it occurs, that the brightness of the star exhibits the most conspicuous range of fluctuation.

G. JOHNSTONE STONEY.

8 Upper Hornsey Rise, N., March 1.

[1] There is quite enough of correspondence between the light curve of those variable stars which have one minimum in each cycle, and the curve of sun-spot frequency, to create an appreciable presumption in favour of the speculation of the present paper.

A New Peripatus from New Zealand.

AS the genus Peripatus is always regarded with exceptional interest by zoologists, I should like to make known through the medium of your columns the discovery of a new and very beautiful species in the dense beech forest at the head of Lake Te Anau, in the South Island of New Zealand. I found it a few days ago in the decaying trunks of trees (presumably beech), and have since collected between twenty and thirty specimens. The species resembles the well-known *P. novae-zealandiae* in shape and size, but is at once distinguished both from it and from the other New Zealand species, *P. suteri*, by the possession of only fourteen pairs of walking legs, and by the presence on the dorsal surface of fifteen pairs of green spots arranged segmentally, one pair over each pair of legs, and one pair over the oral papillæ. The general coloration of the dorsal surface is dark grey mottled with orange, with a dark median band and a black or nearly black triangular patch between each two successive green spots on each side. There are also pale orange or whitish papillæ, very regularly arranged. The ventral surface is mottled grey or violet, with pale areas between the legs. The antennæ are grey, ringed with orange. One specimen is almost jet black on the dorsal surface except for the green spots. Adult females are at once distinguished by the presence of an elongated protuberance between the legs of the last pair. This organ is yellowish in colour and bears the genital aperture, closely resembling the ovipositor of the egg-laying Victorian species, *P. oviparus*. The males are rather smaller than the females, and have a white papilla at the base of each leg of the last nine pairs. I propose for this species the name *Peripatus viridimaculatus*.

Lake Te Anau, N.Z., January 14. ARTHUR DENDY.

Notes on the Occurrence of Amphioxus at Singapore.

THE following notes on the occurrence of *Branchiostoma belcheri*, Gray, at Singapore have been written at the suggestion of Dr. Arthur Willey, who has kindly examined and identified the specimens for me; they were collected by Mr. W. F. Lanchester and myself, and are, I believe, the first that have been obtained from the locality. The first indication we had of the presence of Amphioxus in the district occurred about the middle of November 1898, when a number of young examples were found amongst the material collected by tow-netting at the extreme surface of the water about one or two hours after sunset. At the time we were living on a small island about ten miles off Singapore, and we tow-netted every night just outside or over the edge of the reef surrounding the island. The tidal currents were generally very strong, and no doubt brought a considerable amount of the plankton from the deeper layers to the surface.

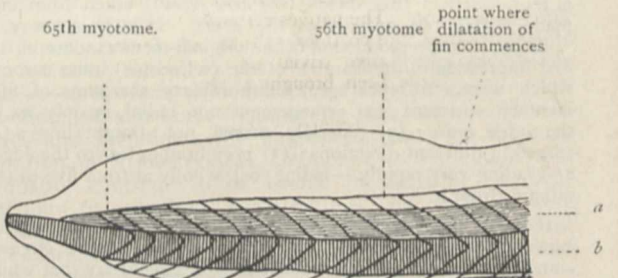


FIG. 1.—*Branchiostoma belcheri*, caudal extremity, before metamorphosis; length of whole larva about 5 mm.

a, Nerve cord; *b*, notochord; *c*, rectum; *d*, ventral fin space.

Up till the end of November (when we left the island) young Amphioxus continued to be fairly plentiful; but they were never met with elsewhere, and in June last year I visited the island again and could find no trace of them.

All these specimens were in different later stages, some having completed their metamorphosis, the fin-rays and ventral fin-chambers being already formed, while in others the gill-slits were still unilateral and opened freely to the exterior.

After the capture of the above examples we repeatedly dredged in the hope of obtaining adult examples, but on only one occasion were we successful, and then only a single specimen was found. It occurred in about six fathoms of water on a bottom composed of somewhat coarse gravel-sand close to the west entrance to Singapore Harbour. I am inclined to attribute our failure in securing more adults to the nature of the ground in which they live. With an ordinary dredge they could easily wriggle through the meshes, and the only time I tried a canvas-bag dredge it filled so rapidly with sand as to be quite useless.

We frequently also used a small shrimp trawl, but it was quite ineffectual as far as Amphioxus was concerned.

Two species of Amphioxus, *Branchiostoma belcheri* and *B. cultellum*, occur in the Malay Seas; the latter is known from Moreton Bay, Torres Straits and Celebes, while *B. belcheri* has been hitherto recorded from Prince of Wales Islands, Torres Straits, Borneo and South Japan, so that either of these species might with equal probability have occurred at Singapore. There is little of interest to note with regard to the specimens themselves. Dr. Willey tells me that in the adult example the "oral cirri are remarkable for the great size of the sense-papillæ which form long projecting conical processes."

In the young, both before and after metamorphosis, the dilation of the dorsal fin at a point vertically above the anus is very marked (see woodcut). This feature has been noted by Mr. Andrews in Japanese examples, and seems to be a point of difference from the specimens examined by Dr. Günther (*v. Zool. Anz.* 18, 1895, p. 59). In the diagram (Fig. 1), which was drawn from a preserved specimen, the notochord is curved up dorsally at the posterior end. This seems to occur in all the preserved examples I have examined, but it is certainly not constant during life. F. P. BEDFORD.

Zoological Laboratory, University College, W.C.

Indian Corn.

I THINK I can satisfy your correspondent, Mr. Kumagusu Minakata (NATURE, February 22, p. 392) about the "maize." I have not Athanasius Nikitin's travels before me, but I have been over a good deal of his ground—and professionally in charge of it—with the book in my pocket.

We cannot now be sure what cereal he meant by "Indian Corn." Probably the term includes several species of Indian millets, great and small; species of Holcus and Eleusine, perhaps even rice. But *Zea Mays*, though well known along Nikitin's line of march, is not a staple grain there even now, though I understand it to be so used, to some extent, a few degrees northwards.

I do not think that any Anglo-Indian botanist will be found to treat it as other than a Portuguese or Musalman importation from the West. The natives certainly look upon it as an imported plant; like potatoes, tobacco, and several others. I suspect that the native trivial name, *Makâ*, implies that some seeds may have been brought to India by pilgrims returning from Arabia.

As to Japan, that country is so much nearer to America, and has so ancient a civilisation and commerce, that I should think it very likely to have received American seeds of maize and of other plants long before the Indian peninsula, though that country is now full of Mexican and Peruvian plants—some thoroughly naturalised—which have come "with the sun."

At one time I thought that there were representations of maize-heads in the Ajantâ caves, but I have had to give the idea up, after examination on the spot. W. F. SINCLAIR.

Chelsea, February 23.

Colour of Horses for Service in Hot Countries.

GENERAL DAUMAS, of the French Army, states in his book on the horses of the Sahara that dark-coloured horses bear great atmospheric heat much better than light-coloured horses. I have had many opportunities in India of proving the correctness of this observation; but I have not been able to find a correct explanation of this fact, and would therefore feel greatly obliged if you or any of your readers would give me it.

When the temperature of the surrounding air is much higher than that of the animal body, the fact of a horse's coat being dark would at first glance appear to be a disadvantage, because it would absorb heat faster than if it were light in colour. Its power of radiation is evidently greater than that of heat absorption. The colour of tropical animals, as we all know, is darker than that of animals in colder climates.

In speaking of light-coloured horses, I refer to the coat (hair) and not to the skin. Absence of pigment in the skin appears to decrease a horse's resistance to the effects of atmospheric heat. Respecting this point, I have not sufficient data to make any definite statement. M. H. HAYES.

Rugby, March 3.

An Interesting Case of Resonance.

A CURIOUS example of resonance is to be noticed in Llandingat Church, Llandovery, South Wales. In one of the windows there is a pane of glass which is not very tightly fixed, being free to oscillate with a definite frequency, which happens to correspond to the frequency of the low pedal "G" of the organ. The consequence is that when the service is taken in G, at the end of each of the Responses, Amens, &c., quite a loud buzzing noise is produced by the resonance of the window; and I have seen strangers sitting near the window seem quite perplexed, not knowing what causes the noise.

Llandovery College, March 4. KENNETH MCMURTRIE.

THE RELATION BETWEEN THE PERIODIC CHANGES OF SOLAR ACTIVITY AND THE EARTH'S MOTION.

ONE of the most interesting questions arising from the problem of the sun's activity is that of a possible connection between the varying display of forces on the solar surface and certain phenomena on our planet. The evidence which has been gradually accumulating can hardly fail to convince us of the existence of an intimate, though still mysterious, relation between some of the manifestations of the earth's magnetic forces and the state of dynamic action on the sun. Not only the extraordinary coincidences repeatedly recorded between solar eruptions and terrestrial magnetic storms, but still more the striking synchronism between the varying frequency of solar spots and the observed changes in the display of auroræ, and in the daily oscillations of the magnetic needle clearly point to that conclusion. Scarcely less certain seems to be the fact, confirmed by many recent investigations, that a greater or less disturbance of the sun's surface is attended by corresponding effects upon terrestrial temperature, rainfall, and other meteorological phenomena.

But there appears to me to be good reason for believing that the influence of the solar activity upon our planet is of an even more profound and far-reaching nature than has hitherto been imagined. I shall endeavour here to state as briefly as possible the results of investigations (more fully developed in *Astr. Nachr.* No. 3619) which have led me to conclude that the period of solar activity can be distinctly traced in the minute residuals which it has not hitherto been possible to eliminate from the observed values of the earth's elements. We are thereby led to infer that the same unknown force which apparently plays so important a part in the meteorology of the sun, acts upon the motion of the earth to such a degree as to produce perturbations which, though minute, are yet of considerable importance from a theoretical and even practical point of view.

As regards the variation of the spot-phenomenon, all the material here required could be taken from Wolf's *Astronomische Mittheilungen*. The chief results which we owe to the never-tiring zeal of this eminent astronomer, and to his intense devotion to this particular branch of astronomical science, are too well known to require, for our present purpose, more than the remark that there are two well-defined periods in the spot-development, the shorter embracing, on an average, about eleven years, and the longer covering, in Wolf's opinion, nearly six times that interval. These two periods are equally important for the following investigation, the curves of the residuals showing the influence of the greater cycle not less distinctly than that of the shorter one. To mention some of the principal features of the "great" spot period—this being probably less familiar to men of science than the eleven years cycle—it may be stated that this curve rises from a minimum near the middle of last century to a high maximum in 1783, then rapidly descends to a low minimum in 1816, attains subsequently another high maximum in 1838, descends again to a moderate minimum in 1861

rises to a small maximum about 1873, and eventually falls to a low minimum in 1888, from which it has since been steadily proceeding to higher values, so that another maximum may be expected in the near future.

Now, to prove our assertion as to a connection between the periodic changes of solar activity and the motion of our planet, we shall, in the first place, consider the changes in the mean obliquity as observed at Greenwich from Bradley's time up to 1896. If, besides the gravitational effects produced by sun, moon and planets, no other perturbing force were acting on the earth-spheroid, the observed values of the mean obliquity should be found to decrease uniformly with the time, this "secular variation" being due to the perturbations produced by the planets. The measured arcs of the obliquity would then be very nearly represented by Leverrier's formula

$$\epsilon = \epsilon_{1850} - 0''\cdot47594\ (t - 1850).$$

Owing to the uncertainty of the values of the masses adopted for some of the perturbing planets, the numerical factor in this equation may have a somewhat different value. But the differences between the observed arcs of the obliquity and the values derived from Leverrier's equation ought in any case to be found to increase or decrease uniformly with time. This, however, is far from being the case, as may be readily seen from the accompanying diagram, in which the abscissæ are represented by the epochs of observation, and the ordinates by the differences Observed Obliquity *minus* Leverrier. The data from 1757 up to 1812 are taken from Prof. Newcomb's treatise, "Elements of the Four Inner Planets, &c., Washington, 1895." Since 1812 the data are deduced directly from the annual Greenwich observations. In order to eliminate any possible influence of the shorter sun-spot cycle, which shall be investigated separately later on, these annual values are combined into groups comprising twelve years of observation. This method enables us to study the waves of long period by themselves, independently of the shorter cycle.

Here, then, it will at once be seen that the observed changes in the mean obliquity cannot be represented by a linear function of the time, but that, besides the secular term, they show three distinct relative maxima and minima. Now the remarkable feature about these turning points is that their positions agree almost absolutely with those exhibited in the "great" sun-spot period. The two high maxima about 1780 and 1840, as well as the very low minimum in 1815, nay even the less pronounced oscillations indicated by the curve of solar spots, are also most clearly recognisable in the curve of the obliquity represented in Fig. 1. In view of so remarkable a coincidence, the observed changes in the obliquity may be closely represented by the introduction into Leverrier's formula of a term depending on the great sun-spot period. If this term, after being evaluated for all the epochs of observation, is subsequently subtracted from the single values of $\delta\epsilon$ in Fig. 1, the following curve is obtained:

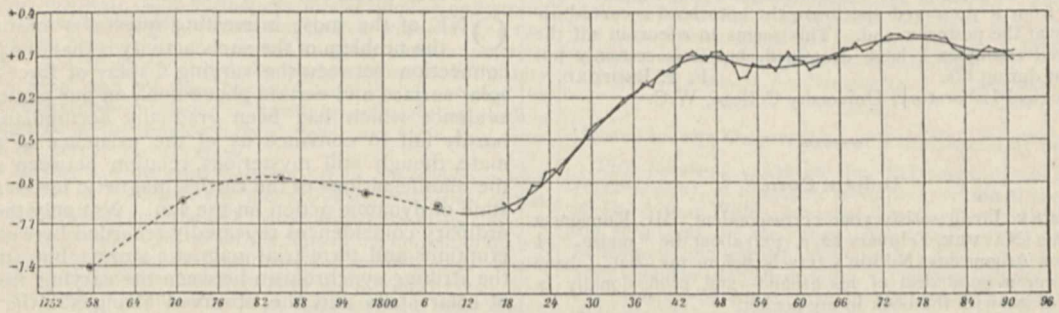


FIG. 1.—Curve of obliquity. (From the *Astron. Nachr.* 3619.)

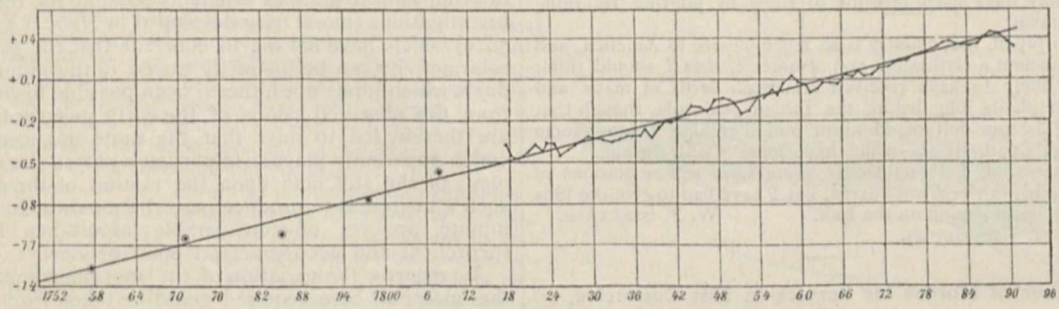


FIG. 2.—Corrected curve of obliquity. (From the *Astron. Nachr.* 3619.)

Now, uniform increase or decrease with time implies that the values of the obliquity should be grouped approximately along a straight line. While this was by no means the case in Fig. 1, it is perfectly true of Fig. 2; and thus it is clear that, taking into account the additional perturbing force due to solar activity, the observed values of the mean obliquity are brought into entire agreement with the deductions of planetary theory.

The significance of the result just obtained is considerably enhanced by the remarkable fact that exactly the same peculiarities appear in the variations of all the other elements of our planet as in those of the obliquity. Not one of the elements, as deduced from observation, can be rigorously represented by a secular term alone; they all show in addition well-marked periodic fluctuations closely agreeing with those of the "great" spot period.

The reality of a distinct, if minute, influence exerted by the changes of solar activity on the earth's motion cannot therefore be doubted, though we are as yet completely in the dark as to the physical causes of this peculiar perturbation.

Now the question arises as to whether traces cannot be discovered of a similar influence upon the motion of the earth-spheroid synchronous with the eleven-years cycle of solar activity. The result obtained on this point receives additional importance from the fact that it throws quite a new light on the theory of a peculiar phenomenon, which has now greatly attracted the attention of astronomers, viz. the *variation of latitude*. The conclusion to be drawn from our investigation points to a close relationship between the amplitude of the motion of the terrestrial pole and the period of solar activity. It may be taken to be clearly established that the radius of the circle described by the pole of instantaneous rotation is greatest at times of sunspot-minima, and smallest at spot spectra during a spot-cycle, the maxima and minima of the spectroscopic curves showing indeed, so far as observations go, a perfect synchronism with those of the curve of latitude-variation.

Judging from these curves the conclusion may be drawn that a very marked influence on the motion of the terrestrial pole of rotation is exerted by a force varying synchronously with the display of spots on the solar surface. Chandler's data previous to 1856 have not been included owing to their incompleteness. But it ought to be mentioned that the correspondence with regard to the positions of the maxima and minima is quite as certain as in the interval exhibited in the above curves. The sun-spot maximum in 1838 is followed by a minimum of the semi-amplitude in 1840, while the next sun-spot minimum in 1843 is succeeded by a very pronounced maximum of the semi-amplitude in 1845. Judging from the epochs of the maxima, the amplitude of the latitude variation completes three full periods in

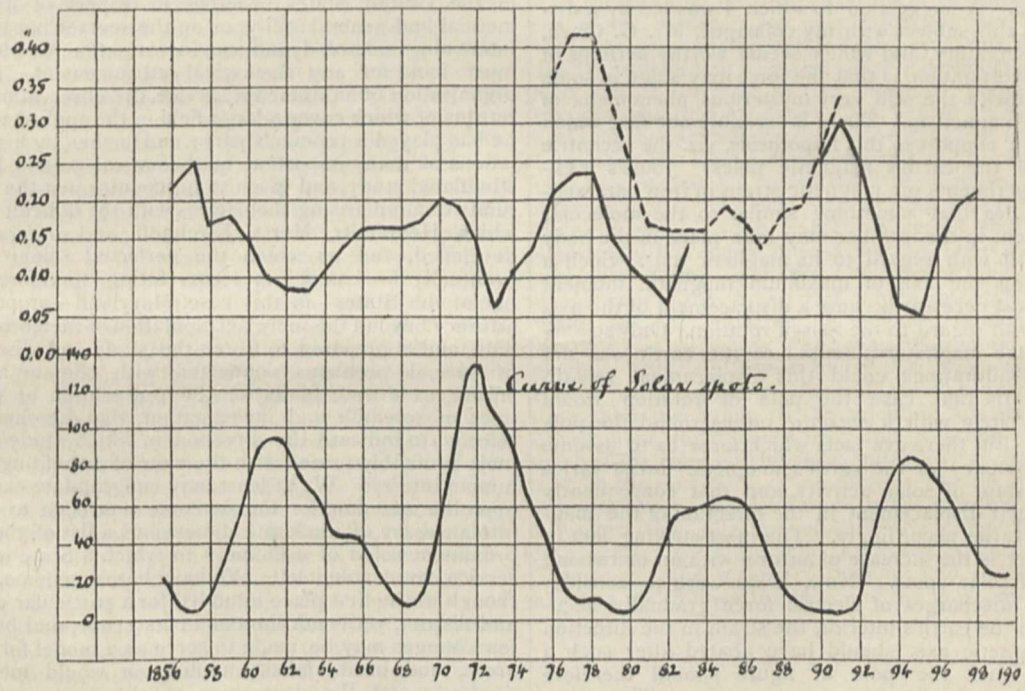


FIG. 3.—Curves of variation of terrestrial latitude, and of solar activity.
The upper curves represent semi-amplitudes of latitude-variation. ——— Chandler. - - - - Nyrén.

times of maximum-displays of solar spots. This correspondence is found to hold true for the whole interval of about sixty years now covered by Dr. Chandler's investigations. The subjoined diagram may help to give a clear idea of this peculiar relation, the first curve showing the semi-amplitudes of the latitude-variation for every year from 1856 to 1898, as deduced from Chandler's curves in *Astron. Journ.* Nos. 277 and 446, and from Dr. Nyrén's values communicated in *Publications de l'Observatoire Central Nicolas*, Série ii. vol. ii.; while the second curve indicates the spot-frequency according to Wolf during the same space of time. As the latitude-phenomenon has been found to lag behind the spot-curve by an interval of about 1·5 years, the latter curve has been shifted one and a half years in the forward direction, in order to establish an agreement between the positions of the maxima and minima of the two curves.

Attention may here be drawn to Sir Norman Lockyer's discovery that a similar lag can be traced in the curves representing the changes in the lines widened in sun-

thirty-four years; while the epochs of the minima make this figure only slightly less, viz. thirty-two years. Hence the period of the amplitude is found to be eleven years.

On the whole, then, we are confronted by the fact, so distinctly brought out by observation, that the motion of our planet reveals traces of the action of a force, the intensity of which can be measured by the state of activity on the solar surface. No doubt, the perturbations caused by this force are extremely minute as compared with the gravitational effects exerted on the earth-spheroid. But still, in the present state of our theoretical knowledge regarding planetary motion, and with the high degree of perfection now attained in the art of astronomical observation, such minute quantities are of considerable importance. This is, for instance, sufficiently illustrated by the derivation of the solar parallax from the secular variations of the obliquity and the node of Venus. The value for this constant, as found after eliminating the perturbing effect of the new solar force from the secular variation of the obliquity, is $\pi = 8''{\cdot}802$, a result which is in perfect

accordance with Newcomb's value obtained from other sources. The great difficulty, by which this distinguished man of science found himself embarrassed in this part of his work (see pp. 158-159 of the treatise quoted above), so much so, indeed, that he well-nigh despaired of arriving at a final conclusion as to the value of π to be adopted, has now disappeared. The values for the masses of the earth, $m(\oplus+\mathbb{C})=1:327923$, as well as of Venus, $m(\varphi)=1:414991$, as derived from the secular variations, may thus be accepted with confidence.[1] This is one example showing the theoretical importance of the phenomena here discussed; possibly the results arrived at may be eventually found to contribute towards removing other difficulties still connected with the theory of planetary motions.

We are, it seems to me, fairly warranted in assuming the force acting in such a peculiar way on the motion of the terrestrial pole to be identical with that which exerts its influence on the secular variations. As regards the nature and origin of this force, there is a wide field for speculation. A suggestion to which I was led by a discussion on this subject with my colleague, Mr. G. Clark, of this observatory, and which seems worthy perhaps of further investigation, is that the force may stand in some connection with the still very mysterious phenomena of the earth's magnetism. There is certainly one fact which lends some support to this hypothesis, viz. the eccentric position of the earth's magnetic poles. Joule's well-known experiments on magnetic strain in iron bars suggest the idea that something similar to the molecular displacement in the iron bar may take place in the body of the earth with regard to its magnetic axis. Such a strain along the axis of maximum magnetic moment would almost necessarily cause a displacement of the axis of figure with regard to the axis of rotation. Only so long as the total magnetic potential of the earth was not subject to alterations could this displacement remain constant. In that case the pole of rotation would describe a circle with a *constant* radius round the pole of figure. But there are facts which force us to assume that the potency of the earth's magnetic forces varies with the state of solar activity, and that consequently the molecular displacement in the direction of the magnetic axis varies accordingly. The most striking fact in this respect is the increase of auroræ with an increasing number of solar spots. Now, if we were to consider auroræ as discharges of electric force gradually accumulated in the earth's interior, the strain in the direction of the magnetic axis should have abated after such a discharge, and the pole of figure should therefore approach the pole of instantaneous rotation. This, then, would explain the fact that the semi-amplitude of latitude-variation is smallest after a maximum display of solar spots. How far this hypothesis is able to account for other phenomena brought out by observation must be left to future research. J. HALM.

Note.—In a very interesting note in *Monthly Notices*, March 1898, Mr. Thackeray investigates the effect of the latitude-variation on the longitudes of the sun as well as on the arc of the obliquity. It appears from his result that the correction to the sun's longitude due to the motion of the pole has an amplitude two and a half times greater than that to the obliquity, cosec. ϵ being almost exactly 2·5. Now from Prof. Newcomb's and Mr. Thackeray's tables showing the corrections to the right ascensions of the sun relative to the stars, as derived from Greenwich observations, I have computed the numerical effect of an error produced in the sun's longitude by an increase from 0 to 10 in Wolf's relative spot-numbers. Assuming Prof. Newcomb's weights assigned to the observations, I obtained $\Delta\lambda = 0''\cdot4457 \pm 0''\cdot0523$, and consequently $\Delta\lambda \sin\epsilon = 0''\cdot1775 \pm 0''\cdot0209$. On the other hand, the value previously found for the obliquity in *Astr. Nach.* 3619, was $\Delta\epsilon = 0''\cdot1703 \pm 0''\cdot0145$. Hence the result that the effect of the force varying with the great spot-period is in point of amplitude exactly analogous to that found by Mr. Thackeray with regard to the phenomenon of latitude-variation. This must, I think, point to the conclusion that those anomalies in the sun's longitude and in the arc of the obliquity which correspond to the great sunspot-period are due to the same force which causes the deviations observed in the motion of the terrestrial pole, that in fact these anomalies are merely another proof of our assertion that the displacement of the pole stands in some connection with the variation of solar activity. The results are derived from two perfectly independent series of observations, the probable errors of $\Delta\lambda$ and $\Delta\epsilon$ being not more than one-tenth of the values obtained; hence the assumption as to the peculiarities elicited from the observations of the sun's right-ascensions and declinations being the result of chance appears to be absolutely untenable. J. H.

[1] This value of the mass of Venus is in close accordance with that derived by Prof. Backlund from the perturbations of Venus on Encke's Comet.

APPLIED METEOROLOGY.[1]

THE name of Prof. Cleveland Abbe is indelibly associated with the onward progress of meteorology in the United States, whether in respect of its commercial and general utility, or on the severer but not less interesting side of dynamical investigation, to which we must look for any theoretical advancement. In the organisation of an immense service, the observations and returns of which cover a large field in the applied science, he has played a yeoman's part; and further, by his translations of many important mathematical papers, he has stimulated study, and given to his countrymen the opportunity of familiarising themselves with the difficult theory which Helmholtz, Hertz, Kirchhoff and others have developed, and on which the perfected science must eventually be based. It seems fitting, therefore, when one of the States—in this case, Maryland—proposes to advance beyond the mere accumulation of meteorological data, and is prepared to foster the study and discussion of special problems connected with climate and its effects, to devote funds for the prosecution of certain lines of research and investigation, that he should be selected to indicate the direction in which study can be most profitably turned with the view of benefiting every human interest. We at least may congratulate ourselves upon the selection, for the outcome has been to collect into an essay of moderate dimensions a list of the most prominent fields of usefulness to which a State weather service can devote itself. We have here a scheme, which though in the first place intended for a particular climate and district, yet is not limited in its scope, and but with few changes may be made to serve as a model for wider areas, and in its fullest application would meet the demands and the necessities of the best instructed meteorologists.

It would be wearisome to give a bare statement of the manifold duties and occupations in which a properly constituted weather service finds itself called upon to take part, and in these pages, fortunately, such a task is not necessary. There may be some who think that weather prediction for shorter or longer periods alone occupies the attention and satisfies the ambition of the meteorologist. To such we commend the list of twenty-nine distinct subjects of enquiry, bearing on every walk of life, assisting every one of the applied sciences, and touching every material interest, that Prof. Cleveland Abbe has put in the foreground of his essay, as additions to the daily storm and weather forecasts, admitted by the least attentive to be the main duty of a meteorological office. But it is needless to say that the author is not satisfied with the mere utilitarian aspect of the science, however valuable the results may be to the agriculturist, the engineer, the mariner, the physician and others throughout the entire circle of the professions. Just as

[1] "The Aims and Methods of Meteorological Work, especially as conducted by National and State Weather Services." By Cleveland Abbe. (Baltimore: Johns Hopkins Press, 1899.)

"The Monsoon Forecast." *The Pioneer*, August 10 and October 23, 1899.

little is he content with that view of popular government, which views favourably the application of scientific results derived from private means and individual enterprise, but does nothing to develop science by research and investigation, on its own initiative. To ask for bricks without providing straw is a complaint that is not limited to one time or one nationality. Prof. Abbe, writing as the adviser of a government prepared to spend its funds on the furtherance of scientific aims, fortunately has not to labour this point; but he nevertheless urges the duty on administrative authority, not only of developing the art of applying the sciences, but also that of constructing them.

The observational side of meteorology has been so long in evidence at the expense of the experimental, that it is very desirable that an eminent authority should insist upon the necessity of experiment and research in physical laboratories, as distinct from the ordinary meteorological observations with which so many observers content themselves. Foremost among the inquiries demanding increased attention, the author places the physical constants pertaining to the atmosphere itself, such as its chemical composition, its weight per unit volume, the law of the relation between pressure, density and temperature, the specific heat of the air, the viscosity, the radiating and absorbing powers, &c.

We need not follow the professor through all the problems that he enumerates calling for increased attention, since every physicist will readily admit that there is a large harvest of information to be gathered in all that concerns the behaviour of the atmosphere, whether at rest or in motion; and every one will find a still larger number of subsidiary problems, awaiting solution, in proportion to the thorough and exhausting character of the work that is bestowed on each main line of investigation. Neither is it necessary to pursue in detail the various topics of applied meteorology, which may at first sight appear somewhat local in their character, but which will be found to apply with very slight modifications to other districts, wherever sufficient enterprise and enlightenment invite the co operation of the physicist in fields of practical utility. It is of more importance, especially in consideration of the matter suggested by the second subject of this article, to see what he has to say concerning the hopefulness of the application of any theory to the problem of the general circulation of the atmosphere. In our wide dependency of India it is necessary at times to deal with imperfect information by imperfect methods; to treat a problem of economic importance with skill based on experience where it is impossible to introduce the certainty that follows mathematical deduction. This course appears to meet with approval, for it is urged that, "for the present at least, it may be wisest to seek for graphic methods and processes of quadrature, which may enable us to arrive at approximate solutions of the complicated systems of equations that represent the interaction of the nine elements that enter into the problem of the motions of the atmosphere." The attitude here suggested is scientific and prudent, and conveys a quiet censure on those who, knowing little of the difficulties that beset the solution, are impatient at the non-fulfilment of forecasts, which the better instructed know are tentative and provisional in their character. To those who exhibit their smartness by immature criticism, we recommend the study of the following paragraph with which Prof. Abbe concludes his review of the general problem. "Add to all these (difficulties) the further consideration that, when once set in motion, the atmosphere may, by some very delicate change in the conditions under which it is moving, assume some obscure form of discontinuous motion, and we at once see that the difficulties of the analytical mechanics of meteorology challenge the intellectual power of man to overcome them."

What, then, is to be said of those, who, occupying a prominent position in journalism, have the opportunity of guiding intelligent opinion, yet use that position with the deliberate intention of discrediting meteorological inquiry and of throwing additional obstacles in the way of those who struggle to solve a problem of enormous magnitude by means of very inadequate data? For this we understand to be the position of Mr. Eliot and his critics, or rather his assailants, for of criticism there is none. It is not contended that an erroneous theory has been pursued, or that some source of information has been overlooked; it is not suggested that any other forecast could have been made from the materials at hand; there is only that kind of cheap sneer, with which we are so painfully familiar, "that all the material which science has so painfully accumulated and laboured over for so many years, can give us no hint of a vital change in the weather, impending at three weeks distance." There is no recognition of the valuable work that the Indian Meteorological Office has inaugurated, and to some extent accomplished, or of the fact that for thirteen consecutive years the forecast of the monsoon has been fairly accurate, and that this is the first conspicuous failure. It seems positively childish to condemn a system which has such a uniformly good record, because in this instance "some obscure form of discontinuous motion" has baffled ingenuity, and disclosed the incompleteness of the data. It is needless to say that Mr. Eliot has a very satisfactory reply to the journalist, or that his reputation stands above any need of our support. The only point which it does seem worth while to make, is to express a regret that a good opportunity has been missed by this influential newspaper for urging upon the Government the necessity of increasing the area over which observations are made, and of educating intelligent opinion as to the direction in which additional information is to be sought. This we conceive to be the proper attitude to assume with regard to the unfortunate forecast. To strengthen the hands of the scientific advisers of the Government would be a worthy and generous motive; to sneer at the energetic officials, and to sow increased distrust on the credibility of weather forecasting, is not only to betray the writer's ignorance, but is criminal, so far as it hinders the collection of data which alone can introduce greater certainty into the forecasts, and give the Government the means of dealing with the enormous suffering that follows the failure of the monsoon rains.

W. E. P.

NOTES.

THE death is announced of Prof. E. Beltrami, professor of mathematical physics in the University of Rome, president of the R. Accademia dei Lincei, and correspondant of the Paris Academy of Sciences.

LORD RAYLEIGH will not deliver the second of his course of lectures on "Polarised Light" at the Royal Institution on Saturday afternoon next (March 10), owing to the sudden death of his mother, the Dowager Lady Rayleigh. There will be no lecture on Saturday afternoon.

THE German Society of Naturalists and Physicians will meet this year at Aachen, on September 17–21.

THE next meeting of the French Association for the Advancement of Science will be held at Paris, on August 2–9, under the presidency of General Sebert.

ASTRONOMERS will regret to see the announcement of the death of Dr. C. T. R. Luther, Director of the Düsseldorf Observatory, and the discoverer of many minor planets.

THE Paris correspondent of the *Times* announces the death, at the age of seventy-four, of M. Emmanuel Liais, Mayor of Cherbourg. For many years he held posts at the Paris Observatory, and he was sent in 1857 to South America to observe the solar eclipse. He organised telegraphic meteorology in France, and devised the use of chronographs in determining longitude by electricity. He also devised a system of automatic magnetic registration by photography, and applied the method of the polarisation of light to the investigation of the solar corona. He bequeaths his property to the municipality of Cherbourg in trust for scientific purposes.

THE death of the distinguished geologist, Dr. Hans Bruno Geinitz, is announced in the *Geological Magazine* for March. Born on October 16, 1814, at Altenburg, in Saxony, he was educated at the Universities of Berlin and Jena, and gained the foundations of his geological knowledge under Quenstedt. In 1850 he became Professor of Mineralogy and Geology in the University of Dresden. He was elected a Foreign Member of the Geological Society of London in 1857, and received the Murchison Medal in 1878. His labours were devoted mainly to the geology and palæontology of the Palæozoic and Cretaceous rocks of Saxony, and in particular to the fauna and flora of the Dyas or Permian formation. He died at Dresden, on January 28, aged eighty-five.

A RATHER severe earthquake was felt throughout the greater part of Venetia on March 4, at about 5 p.m. (G.M.T.), strong enough to produce a stampede from the churches in Padua, Venice and Verona, but not causing much damage to buildings, and, so far as known, unaccompanied by loss of life. The epicentre of the earthquake appears to have been not far from Monte Baldo, near Verona. This is a well-known seismic district, the earthquakes of which, and especially that of June 7, 1891, have been discussed in a valuable memoir by Dr. M. Baratta, published in the *Annali* of the Central Office of Meteorology and Geodynamics of Rome.

THE last letters received from Mr. J. E. S. Moore's expedition are dated from Ujiji, on Lake Tanganyika, on November 12, 1899. The other members of the party had proceeded to the north end of the lake, where Mr. Moore was proposing to join them so soon as the necessary number of porters had been assembled. The expedition had been fairly successful both in collecting zoological specimens from the lake and in studying the geological features of the surrounding district. They had obtained numerous living specimens of the curious forms of mollusca of the lake, besides a good series of fishes and crustaceans. The celebrated jelly-fish (*Limnocnida tanganjicae*) had been met with in great numbers. Mr. Moore had escaped fever altogether, but most of the other members of the party had had a touch of it.

THE pair of Grevy's zebras presented to the Queen by the Emperor Menelek, and placed by Her Majesty under the care of the Zoological Society of London, on August 14 last, have now completely recovered the effects of their journey, and appear to be in fine health and condition. It will be evident to all who see these splendid animals that Grevy's zebra (*Equus grevii*) is by far the finest and most distinct species of the group of "striped asses," excelling its brethren both in size and in beauty of markings. There are pairs of both the Mountain zebra (*Equus zebra*) and the Burchell's zebra (*E. burchelli*) in the Society's zebra-house, only the extinct Quagga (*E. quagga*) being unrepresented in the series.

THE "Zoological Lectures" of the Zoological Society of London will be delivered this year in the Meeting-room at Hanover Square, instead of at the Gardens. They will be given on Thursdays, April 19, May 17, June 21 and July 19, at 4.30 p.m. (after the General Meeting). The first lecture, on April 19, on the "Animals of Australia," will be delivered by Mr. Smith-Woodward, of the British Museum.

DURING the last week, Mr. Garstang, of the Marine Biological Laboratory, Plymouth, carried out the fifth of his periodic surveys of the plankton and physical conditions of the mouth of the English Channel. This concludes the series provided for by the British Association at the Bristol and Dover meetings, and the Committee may be congratulated on the successful termination of an interesting series of experiments, a full account of which is promised for the Bradford meeting. Compared with the corresponding observations made at the same stations in February 1899, the water temperatures at all four stations on the last cruise showed a distinct fall, which amounted to a mean reduction of 1·3° F. in mid-Channel, 2·0° F. off Ushant, 0·7° F. off Parson's Bank, and 1·5° off Mount's Bay. Nevertheless, an axis of warm water running up Channel in a north-east direction was again observed, thus tending to establish this condition as a normal phenomenon for the winter period. The vertical and closing nets showed the existence of suspended sand and mud in the water to a height of more than 40 fathoms above the bottom—a convincing testimony of the force of recent gales.

A FRENCH translation of two of Prof. W. H. Corfield's three Harveian Lectures on disease and defective house sanitation, delivered in 1893, has been published in the *Bulletin* of the Royal Society of Public Health of Belgium, of which Society Prof. Corfield is a "Membre d'honneur."

THE Istituto Lombardo announces the following as the subjects for future prizes:—The Institution prize for 1900 will be awarded for an essay on collective proprietorship in Italy; competition closes April 30, 1900; for 1901, on differential equations occurring in electrical problems; closing April 1, 1901. The two triennial medals for 1900 are for industrial and agricultural innovations in Lombardy. One Cagnola prize for 1900 is for an essay on "toxin and antitoxin"; closing April 30; and the subject for 1901 is a study of the storms, especially hail-storms, on the slopes of the Alps; last day, April 1. For the remaining Cagnola prizes the subjects have been chosen by the founder, viz. the cure of pelagra, the nature of miasma and contagion, the control of flying balloons, and the methods of preventing the forgery of a document; the closing day being December 31. The Brambilla prize, as in preceding years, is awarded for improvements in manufacturing industries in Lombardy. For the Fossati prize, the themes for next year is "regeneration of the peripheric nervous fibres in vertebrates," and for the two succeeding years, "illustration of some fact in the macro- or microscopic anatomy of the encephalus of the higher animals; entries close about the end of April. The Kramer prize is restricted to Italian engineers. For the Secco Comneno prize for 1902 the subject is a description of the deposits of natural phosphates in Italy, the competition closing on April 30, 1902. The subjects for the Pizzamiglio prize are, for 1901, secondary education; and for 1902, influence of socialistic doctrines. The Ciani prizes are to be given for the best Italian popular book, the type of book selected being scientific or educational for 1901, historical for 1904, and "narrative or dramatic" for 1907. The Tommasoni prize is to be given for the best life of Leonardo da Vinci; and the Zanetti prize for Italian improvements in pharmaceutical chemistry. The prizes, with certain specified exceptions, are open to competitors of every nationality, and the essays may be written in French, Italian, or Latin; but for full particulars we must refer to the Society's *Rendiconti*, vol. 33, part 1, or to the Secretary, Signor Ferrini, Palazzo di Brera, Milan.

PROF. A. HEILPRIN points out in the *Scientific American* that a source of doubt which attaches to the Nicaragua Canal and involves the question of permanency is furnished by the level of Lake Nicaragua—the fountain-head of the San Juan River, and the summit and feeder of the proposed canal. The regulation of its level is necessarily a matter of absolute or vital importance to the canal. The very elaborate measurements of American engineers that have been made during the last fifteen years indicate for the surface of the lake an average elevation at this time of approximately 105 feet above tide. This is nearly twenty per cent. less than the value obtained some years ago; and as the result of a consideration of the subject, Prof. Heilprin thinks it would not be safe to assume that the earlier measurements of the lake were erroneous. He thinks it more probable that the level of Lake Nicaragua is inconstant, and that the surface has dropped 15 to 20 feet in a period of little more than half a century.

THE effects of the great dynamite explosions at Avigliana (near Turin), on January 16, are described by Dr. M. Baratta in a privately printed pamphlet. About 400 kg. of nitro-glycerine and 12,000 kg. of dynamite and gun-cotton were blown up. The first and stronger explosion, though it lasted little more than a second, presented three maxima of intensity, due probably to the successive explosions of magazines a hundred metres from that in which the nitro-glycerine was stored. Owing to the situation of the manufactory, the zone of greatest damage was very small; that in which windows were almost totally destroyed extended to a distance of 5½ km.; doors and windows were made to rattle as far as Crescentino (60 km. distant); and the sound of the explosion was heard at Pavia (140 km.), Varzi (145 km.) and Lugano (160 km.).

WE have received from Prof. Albin Belar the first part (for January 1900) of a monthly report on the earthquakes recorded at the seismological observatory of Laibach, of which he is the director. Some brief notices of earthquakes which occurred in other countries during the same month are also included. As Laibach is one of the most important earthquake centres in Europe, the reports issued from the observatory cannot fail to be of considerable interest and value.

AN interesting lecture was recently delivered by Dr. J. M. Pernter before the Austrian Meteorological Society, upon some extensive experiments made in several Italian provinces last year for the prevention of damage by hail by gun-firing. The idea is an old one, but the apparatus, constructed by Mr. A. Stiger, burgomaster of Windisch-Feistritz, Steirmark, consisting of a mortar provided with an iron funnel about six feet long, appears to have obtained very satisfactory results. The experiments were witnessed by Dr. Trabert, of the Vienna Meteorological Office, and it was found that a timely commencement of the firing effectually prevented the fall of hail, whereas in districts where the experiments were not made much damage was caused by hail-storms. The immunity from damage may have been due to the force of the air-whirls, the sound of which could be heard for twenty or thirty seconds, or to the fact that the electrical discharge between the earth and the clouds was quietly effected by the shooting, and thus the chief factor of hail formation removed.

THE Victor Meyer Memorial Lecture, delivered by Dr. T. E. Thorpe, F.R.S., before the Chemical Society on February 8, is published in full in the March number of the *Journal* of the Society, with an excellent portrait of the lamented investigator. Many scientific societies, both abroad and at home, issue their publications in so tardy and irregular a manner that the example of the Chemical Society in publishing the *Journal* regularly every month might be followed with advantage. Few societies publish discourses so elaborate as that of Dr. Thorpe's within three weeks of their delivery. It is unnecessary for us to do more than briefly refer to the address, as a notice of the work and personal characteristics of Victor Meyer appeared in these columns in September 1897, shortly after his death (vol. lvi. p. 449). As a friend of nearly thirty years' standing, and as one who studied with him under Bunsen, Dr. Thorpe was in the position to give an excellent account of the remarkable services Victor Meyer rendered to science during his life. Meyer contributed to the literature of chemistry, either alone or in conjunction with his pupils, upwards of three hundred memoirs and papers. As an investigator, he was original as well as active; as the director of a large chemical laboratory and a laboratory teacher, he worthily followed in the footsteps of Bunsen; and, as a lecturer, he was brilliant as well as lucid. Dr. Thorpe's lecture is a worthy appreciation of the genius of a gifted man who devoted his energies to the advancement of science.

MR. T. SOUTHWELL contributes to the *Zoologist* his annual account of the seal and whale fishery. From this we learn that the pursuit of the Greenland Bight Whale was fairly successful during the past season; a remarkable feature being that although none of these Cetaceans were seen in the Greenland seas, they were comparatively plentiful in Davis Strait and the adjacent waters. The majority of the twenty-eight whales taken were of good size, some of them being of very large dimensions. During the year the price of whalebone fell to 1400*l.* per ton, although more is now asked; in past years more than 2500*l.* per ton has been realised. Mr. Southwell points out, as a matter for regret, that the sealers have recently taken to collecting musk-ox hides, which may easily lead to the extermination of that remarkable animal, unless efficient measures be promptly taken for its protection.

IN the March number of *Photography*, Mr. Douglas English gives the results of his experiments on photographing living fish—an art that has hitherto received but little attention. How necessary is this art, if we wish to have correct portraits of fish, will be apparent when the remarks of the author are read as to the immense alteration which takes place in their bodily form and proportions immediately after death. The difficulties with which the photographer has to contend are the mobility of the fish, which necessitates very short exposures; the great loss of actinic power in white light resulting from its passage through glass and water; and, in some instances, the delicacy of the subject and its terror under the operation. In order to counteract the first of these difficulties, Mr. English has adopted the principle of the "animalcule-tank" employed in connection with the optical lantern. After several attempts, a tank was invented capable of confining a living fish within a space sufficiently limited to enable the photographer to keep it in some degree in focus, the sides being constructed of two parallel plates of the thinnest and whitest plate-glass procurable, with provision for increasing or narrowing its diameter, within certain limits, according to the size of the fish. Several examples of the photographs thus obtained are reproduced; and although their definition is not as sharp as might be desired, they are life-like portraits which ought to be of the highest value to the naturalist.

MR. BARRETT-HAMILTON is turning his attention to the cause of the colour-change in animals which turn white in winter. In a recent issue of the *Proc. Zool. Soc.* he corroborates the view that the darker colour of the summer coat of the Arctic hare is due to the casting off of the white winter hairs and their replacement by a new growth. In the January number of the *Annals and Magazine of Nat. Hist.*, Mr. Hamilton discusses the local colour-phases of the Weasel. In the far north, as is well known,

this animal turns white in winter; in the north temperate regions the reddish-brown of the upper parts is permanently retained, although the under surface is pure white; but as we proceed further south, we find weasels with the under parts more and more suffused with yellow, till in parts of the Mediterranean area the colour is buff or orange. Such increased richness of coloration in the southern part of the habitat of the weasel is paralleled among many birds.

ON the delivery of the Hunterian collections into the custody of the Royal College of Surgeons, by Government, at the beginning of the century, it was stipulated that lectures illustrative of the series should be annually delivered in the theatre. According to a list prepared by the Librarian, the lectures commenced in 1810, when those on comparative anatomy were delivered by Sir Everard (then Mr.) Home, and those on pathology by Sir William Blizzard. Since that date they have been continued almost without intermission; the roll of lecturers including the names of many of the most eminent comparative anatomists and surgeons.

WE have received from the author, Monsieur H. de Varigny, a paper published in the Jubilee volume of the Société de Biologie, entitled "Sur le Notion Physiologico-Chimique de l'Espèce," which contains much curious speculation.

FROM Prof. R. Collett we have received the second part of his contributions to the natural history of those small blenny-like fishes known as *Lycodes*, published in the *Vid.-Selsk. Skrifter Christiania*, 1899, No. 6. He there describes the life-history of *L. gracilis* from an early period till it is capable of propagation. The question is, however, mooted whether we yet know the fully adult stage of this little fish, which may possibly reveal itself in some familiar type of which the youthful condition is unknown.

DR. HERMANN VON SCHRENK has made a minute investigation of a wide-spread disease, known as peckiness and pin-rot, affecting the heart wood of the bald cypress and the incense cedar, and his observations are contained in a thesis published in the eleventh annual report of the Missouri Botanical Garden, of which Mr. W. Trelease is the director. Both these trees are representatives of a race of trees the majority of which are extinct, and in both a fungus mycelium occurs with strongly marked characteristics. The peculiar decay to which the two kinds of trees are subject appears to be caused by this fungus, the fruiting form of which has not yet been found. Dr. Schrenk has examined logs of the cypress dug up from various points in the Mississippi valley, several miles from the river, and at an average depth of ten feet below Gulf level, and he has found unmistakable evidence of the disease, which is prevalent wherever cypress grows in abundance at the present day. It therefore seems that the disease is one which has extended back for some thousand years at least, and probably further. As few fungi are known in the fossil condition, the observations are of particular interest, for they suggest that this peculiar fungus disease of the cypress and cedar has come down with its host from geologic times.

"EINE Landschaft der Steinkohlen Zeit" is the title of an explanatory pamphlet accompanying Dr. H. Potonié's recently issued wall-diagram to illustrate the leading features of the Coal-Measure flora. A reduced facsimile of the diagram itself, with an accompanying outline key-plate, forms a suitable frontispiece, and the forty pages of the pamphlet are further enriched by numerous excellently reproduced figures in illustration of the structural and morphological details briefly referred to in the text. In accordance with the author's view, which supposes an autochthonous origin for coal, the restoration here put forward represents a rich assemblage of typical coal plants growing upon a perfectly flat and more or less marshy surface. It is claimed that the reconstruction of the types here depicted is in all cases founded upon the soundest evidence as regards the actual relationship of parts.

IN the first instalment of a work on the geology of the oil-bearing strata of Galicia ("Geologie der Erdöl-Ablagerungen in den galizischen Karpathen." Lemberg, 1899), Prof. Rudolf Zuber deals with the stratigraphy of the Galician Carpathians. Of importance, as regards the yield of petroleum, is that group of beds known as the "Ropianka-Schichten," concerning the age of which, however, there has been considerable controversy. Classed originally as Tertiary, these beds, by the discovery of unmistakable though somewhat scanty palæontological evidence, were subsequently recognised as Cretaceous, but their position in the Cretaceous System has long remained a matter for dispute. In the present paper the author, after reviewing the results of previous writers, brings forward his reasons for considering these Ropianka-beds as the undoubted equivalents of the Neocomian stage in Silesia. The Tertiary rocks are well represented in Galicia, and include oil-bearing strata at several horizons. The Eocene System, which shows a locally developed nummulitic facies, comprises the most important petroleum-yielding beds. Oil occurs also at horizons of Oligocene and Miocene age.

A PAPER upon "Life under other conditions" is contributed by Mr. Geoffrey Martin to *Science Gossip* for March. The subject is one which has been recently worked out by Dr. F. J. Allen; and Mr. Martin's general conclusions seem to agree up to a certain point with Mr. Allen's, at any rate in the view that vital processes depend on the existence of an element, the compounds of which are in a condition of critical equilibrium at the temperatures at which life exists. But Mr. Martin appears to regard carbon as the substance which acts the *rôle* of the fundamental element in the animal organism; while, according to Dr. Allen, nitrogen plays an all-important part in determining vital phenomena. Mr. Martin suggests that at the higher temperatures which may exist on other celestial bodies, or which may have existed at one time on our earth, silicon may give rise to a series of compounds analogous in their complexity and instability to our "organic" carbon compounds, and under such conditions what we may call "silicon life" may exist. In connection with this view it is somewhat interesting to notice that the power of secreting silica is now possessed by what we may regard as among the lowest types of vegetable and animal life, diatoms and sponges. But of course there is a wide difference between the temperatures required for carbon life, or, as Dr. Allen calls it, nitrogen life, and Mr. Martin's hypothetical silicon life.

THE Oxford University Junior Scientific Club has just issued its *Transactions* for the Summer and Michaelmas Terms of 1899, containing papers by Mr. H. E. Stapleton, on "An Extension of Dulong and Petit's Law," and by Mr. A. Gibson, on "The Retention of Plant-food in the Soil."

THE latest report of the U.S. National Museum is a volume of 1021 pages. One quarter of the volume deals with the condition and progress of the Museum during the year ending with June 1897; the remaining three quarters consists of seven elaborate papers describing collections in the Museum, and illustrated with the liberality and excellence which distinguishes the publications of the Smithsonian Institution and of the various official Bureaux of the United States. Dr. J. M. Flint describes the specimens of foraminifera obtained during the dredging operations of the U.S. Fish Commission steamer *Albatross;* and his paper is illustrated by no less than eighty

collotype plates, each containing several figures reproduced from photographs of mounted specimens, enlarged by about fifteen diameters. The pipes and smoking customs of the American aborigines form the subject of a paper by Mr. J. D. McGuire. Mr. W. Tassin contributes a descriptive catalogue of minerals classified according to their chemical and physical properties. Easter Island and its inhabitants are described by Dr. G. H. Cooke. Dr. O. T. Mason has a short paper on the forms of the man's knife among North American Indians, and Dr. Thomas Wilson describes arrowpoints, spearheads, and knives of prehistoric times, his paper being illustrated by sixty-five plates, and two hundred text figures. Each of the papers is filled with information, and their attractive setting will excite the unstinted admiration of every student of science who sees the volume.

SEVERAL new editions of established scientific works have lately been received. The sixteenth edition of "Kirkes' Hand-book of Physiology," by Prof W. D. Halliburton, has just been published by Mr. John Murray. The fifteenth edition was only published a year ago, so few changes were necessary; but where required, the subject-matter has been brought up to date.—The fourth German edition of Prof. O. Hammarsten's "Text-book of Physiological Chemistry" has been translated by Prof. J. A. Mandel, New York University. The translation, which is published by Messrs. J. Wiley and Sons, is now in its third edition, and most of the available literature up to April last year is taken into account.—A second and enlarged edition of Prof. S. P. Thompson's work on "Polyphase Electric Currents and Alternate Current Motors" has been published by Messrs. E. and F. N. Spon, Ltd. The book has undergone revision, and has been improved in several respects. The chapters on graphic theory have been developed by Mr. Miles Walker, and the theory is now presented in such a shape as to be directly available for practical calculations. Many of the illustrations are new, and coloured plates are now used to elucidate various types of polyphase windings.—The third edition of Prof. J. R. Ainsworth Davis's book on "The Flowering Plant, as illustrating the First Principles of Botany" has been published by Messrs. C. Griffin and Co., Ltd. New illustrations have been added; and also a chapter on ferns and mosses, which, though not comprehended by the title, will assist students to understand the life-history and classificatory position of flowering plants.—The first part of a second revised and enlarged edition of Dr. Julius Wiesner's work on "Die Rohstoffe des Pflanzenreiches" has been published by W. Engelmann, Leipzig. The first edition appeared in 1873, and it is expected that the present one will be completed during this year. The book appeals more particularly to students of economic botany and pharmacy.—A revised edition of "The Photographer's Note-book and Index, with Tables and Exposure Rules," by Sir David Salomons, Bart., has been issued by Messrs. Marion and Co.

SINCE the discovery by Curtius of the remarkable compound of hydrogen and nitrogen, hydrazoic acid, numerous attempts have been made to obtain from it the condensation product N_6, and during the discussion at a recent meeting of the Chemical Society, Prof. Ramsay gave a short account of some experiments made in this direction in his laboratory by the interaction of silver azoimide and iodine. The wished-for substance could not be isolated, but Prof. Hantzsch, in the current number of the *Berichte*, has now succeeded in isolating a definite iodide of nitrogen from the products of this reaction. By working at a low temperature and as rapidly as possible in the presence of ether, the new iodide is taken into solution by the latter, and can be obtained as a yellowish solid in minute quantities, not exceeding 0·2 gram, by the rapid evaporation of the ether. The solid is too unstable to submit to analysis, but an examination of the solution showed that its composition was N_3I. As might be expected from this formula, the iodide is violently explosive, 0·2 gram on one occasion completely pulverising a glass desiccator. Attempts to prepare N_6 by the action of the iodide upon silver azoimide, or by the spontaneous decomposition of the iodide, were unsuccessful.

THE theory of electrolytic solution pressure of Nernst has opened a wide field of research, and has led to many interesting developments. It is still, however, open to question whether the osmotic pressure analogy has not been pushed too far, and in the current number of the *Zeitschrift für Physikalische Chemie* is a short criticism by Prof. Lehfeldt on this point. Taking the solution pressures calculated for zinc, nickel and palladium from the observed electromotive forces as $9·9 \times 10^{18}$, 1·3, and $1·5 \times 10^{-36}$ atmospheres respectively, it is pointed out that although the first number is enormous it is not necessarily impossible. It is otherwise with the figure for palladium. Since pressure is a statistical effect, a considerable number of molecules must act on unit area. $1·5 \times 10^{-36}$ atmospheres would give one or two molecules of palladium in a volume the size of the earth.

THE fact that such common alkaloids as cocaine, atropine and nicotine are derivatives of pyrrol lends considerable interest to syntheses of derivatives of the latter substance. Pyrrol-aldehyde, the analogue of benzaldehyde and furfuraldehyde, has hitherto been wanting, but its preparation has now been successfully attempted by Bamberger and Djierdjian by the use of Reimer's reaction with chloroform and potash, and is described by them in a preliminary note in the current number of the *Berichte*. The new aldehyde forms a well-crystallised hydrazone, oxime, and also an insoluble sodium sulphite compound, but differs markedly from its analogues in crystallising readily, prisms several centimetres long being obtainable, and also in possessing no smell. Many important synthetical products may be expected with pyrrol-aldehyde as a starting-point.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*), a Serval (*Felis serval*) from South Africa, presented by Mr. J. E. Matcham; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Dudley B. Myers; a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Miss M. C. Glover; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Lieut.-Colonel Hopton; four Black-bellied Sand-Grouse (*Pterocles arenarius*) from Spain, presented by Mr. G. P. Torrens; a Purplish Death Adder (*Pseudechis porphyriacus*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

OCCULTATION OF NEPTUNE.—There will be an occultation of Neptune on the evening of March 8, the moon having just passed its first quarter.

	Mean Time.	Angle from North Point.	Vertex.
	h. m.	°	°
Disappearance	6 13	101	107
Reappearance	7 34	268	249

As the moon passes the meridian of London about 6.30 p.m., the occultation is a favourable one for observation should the weather permit.

OPPOSITION OF MINOR PLANET (434), HUNGARIA.—Herr A. Berberich, of Berlin, gives in the *Astronomische Nachrichten* (Bd. 151, No. 3624) a revised set of elements and the deduced ephemeris of this body, to facilitate its detection during the coming opposition about March 23.

Elements for 1900 *March* 5, *Berlin Mean Time.*

M =	244° 34′ 15″·3	
ω =	122 55 42·3	} 1900·0
Ω =	174 39 17·4	
i =	22 30 32·0	
φ =	4 15 30·9	
μ =	1308″·6777	
log *a* =	0·2887826	

Ephemeris for 12*h*. *Berlin Mean Time.*

1900.	R.A. h. m. s.	Decl. ° ′
March 7 ...	12 14 55 ...	−0 50·1
11 ...	11 56 ...	+0 36·5
15 ...	8 40 ...	2 6·1
19 ...	5 13 ...	3 37·3
23 ..	12 1 41	5 8·5
27 ...	11 58 10 ...	6 38·1
31 ..	11 54 45 ...	+8 4·5

CERASKI'S SECOND ALGOL VARIABLE.—In the *Harvard College Observatory Circular*, No. 47, Prof. E. C. Pickering furnishes the additional data respecting this variable which are available from the photometric records of the Henry Draper Memorial. The Moscow photographs furnish the means of determining the period from an interval of *four* years; the Harvard records increase this interval to *nine* years. With the aid of the latter it is found that the formula of Prof. Ceraski only satisfies the later observations, and to remedy this the period he gives should be shortened by 0·6m.; the resulting period of 6d. 0h. 8·8m. satisfying all the observations since 1890 very accurately, but more observations of the minima will give a still closer value. The period, however, differs so slightly from exactly six days that for a long time the minima cannot be observed in certain longitudes. Accordingly, while observations may be obtained in the ensuing autumn in Europe, or better still in Asia, minima cannot be observed in America until the following year.

Five stars of the Algol class, viz. S Cancri, U Cephei, W Delphini, +45°·3062 and the star here under discussion are especially interesting owing to the large variation in their light, which amounts to about two magnitudes in each case. It is noteworthy that of these two were found by Mdme. Ceraski, and one by her distinguished husband.

THE NEW ODESSA OBSERVATORY.—Herr A. Orbinski, who has been appointed director of the new astronomical observatory at Odessa, has recently issued his first report, dealing with the foundation of the institution, its instrumental equipment, and the scope of the proposed programme of investigation.

The observatory has been established as a branch to the great national institution by the governing body of the Pulkova Observatory, chiefly owing to the efforts of Prof. O. Backlund during 1895 and afterwards.

In the summer of 1897 the building operations were commenced, and in August of the following year, 1898, the transit instrument was installed, the vertical circle being set in position during February 1899. The buildings are three in number—a transit house, and two buildings for housing the meridian marks, or collimators. The instrumental equipment consists of a transit circle, with clock, chronograph and meridian marks, and a vertical circle.

The transit has an objective of 108 mm. aperture and 1·30 m. focal length, by Steinheil, and is furnished with a self-registering micrometer, by Repsold. The meridian marks are situated about 119 metres north and south of the transit pier, and consist of round plates, each pierced with a small hole 1·5 mm. in diameter, which being illuminated from behind by an electric lamp, forms an artificial star of about 2-1 magnitude.

The vertical circle, by Repsold, has a Steinheil objective of 108 mm. aperture and 1·40 m. focal length. Both these instruments are mounted in the same transit house, which is so constructed that, the central portion remaining stationary, the ends may be traversed eastwards and westwards respectively, thus uncovering the instruments.

The programme of the observatory is to be somewhat similar to that at Pulkova, except that observations of stars are to be made alternately with each instrument night by night, and not with both together, the first list of 176 stars being included in the report.

HARTLEY BOTANICAL LABORATORIES OF UNIVERSITY COLLEGE, LIVERPOOL.

AFTER occupying for twelve years small and, in many respects, unsuitable rooms in the old College buildings, the botanical department of University College, Liverpool, is at length to be housed in a new and commodious institute, the munificent gift of Mr. W. P. Hartley, of Aintree, Liverpool.

The site of the new buildings, also purchased by Mr. Hartley for the College, is a very fine one. The buildings have an east frontage of 37 feet and a north frontage of 85 feet. The total height to the eaves is 54 feet, divided into three principal stories, with two mezzanines in addition to a basement.

The main entrance leads through a vestibule, 8 feet wide, into a hall, 23 feet by 20 feet, in which is placed the staircase, 6 feet wide, open by means of a well to the lantern light at the top of the building.

The basement floor is occupied by store-rooms, lavatories and heating chamber.

The ground floor is mainly occupied by the museum, 45 feet long by 34 feet broad. This is surrounded at a height of 10 feet 6 inches by a balcony with open ironwork balustrade, which can be entered from the mezzanine floor or by an iron spiral staircase from the ground floor of the museum. The museum will throughout be fitted with cases made of American canary wood with movable glass shelves. It is intended that these cases shall contain not only morphological specimens illustrative of the scientific aspect of botany, but also specimens of all products of the vegetable kingdom used in the arts, such as timbers, pharmaceutical products, cottons, hemp, flax, and food products, both in the raw and in the manufactured state. It is hoped that by this means the new botanical laboratories will become a centre of information for the general public on matters of economic botany as well as on the more strictly scientific aspects of the science.

The museum will be provided with a lift running to all the floors above, so enabling specimens to be expeditiously and conveniently made available for teaching purposes in the laboratories and class-rooms.

On the ground floor also there is a workshop fitted with lathe, carpenter's bench and tools, so that small repairs may be carried out and simple machinery constructed without necessitating the calling in of special workmen.

There is also, in connection with the museum, a preparation room, in which stock museum jars and boxes will be kept, and in which the various specimens to be exhibited in the museum will be mounted, prepared and labelled.

The first mezzanine floor is partly occupied, as already mentioned, by the museum balcony; but there is also on this floor a small class-room fitted for about twenty students, furnished with the necessary fittings for the teaching of advanced lecture classes; and the herbarium fitted throughout with dust-tight cases and boxes for dried plants. Room is also provided on this floor for a staff lavatory.

On the first floor is placed the large lecture theatre. This room, which is 45 feet long by 34 feet broad, will accommodate 100 students. The seats are raised at the back by a gradually increasing upward curve, and the room is fitted with a specially designed lecture table, carrying electric switches, gas, water, and other needful appliances for public lectures. Opening off the theatre is the professor's private room, with an adjacent private laboratory, both of which will be furnished and equipped with the requisite bookcases, apparatus cases, and laboratory appliances. On this floor also is situated the departmental library, whose shelves will be furnished with not only the best known botanical text-books for reference, but also with several of the more important botanical journals.

The second mezzanine floor carries the research laboratory, the experimental physiology laboratory, and the dark room. These rooms, perhaps the most important in the building, will be fitted with all the more essential appliances for anatomical and physiological research, whilst the dark room will be available both for microphotographic work and for such physiological experiments as can be conducted only in the absence of light.

On the second or top floor is placed the large and magnificently lighted junior laboratory, capable of accommodating sixty-five students at one time, and fitted with specially constructed benches, cases for microscopes and apparatus, and the necessary teaching appliances. There will also be placed on this floor a fully equipped senior laboratory, capable of accom-

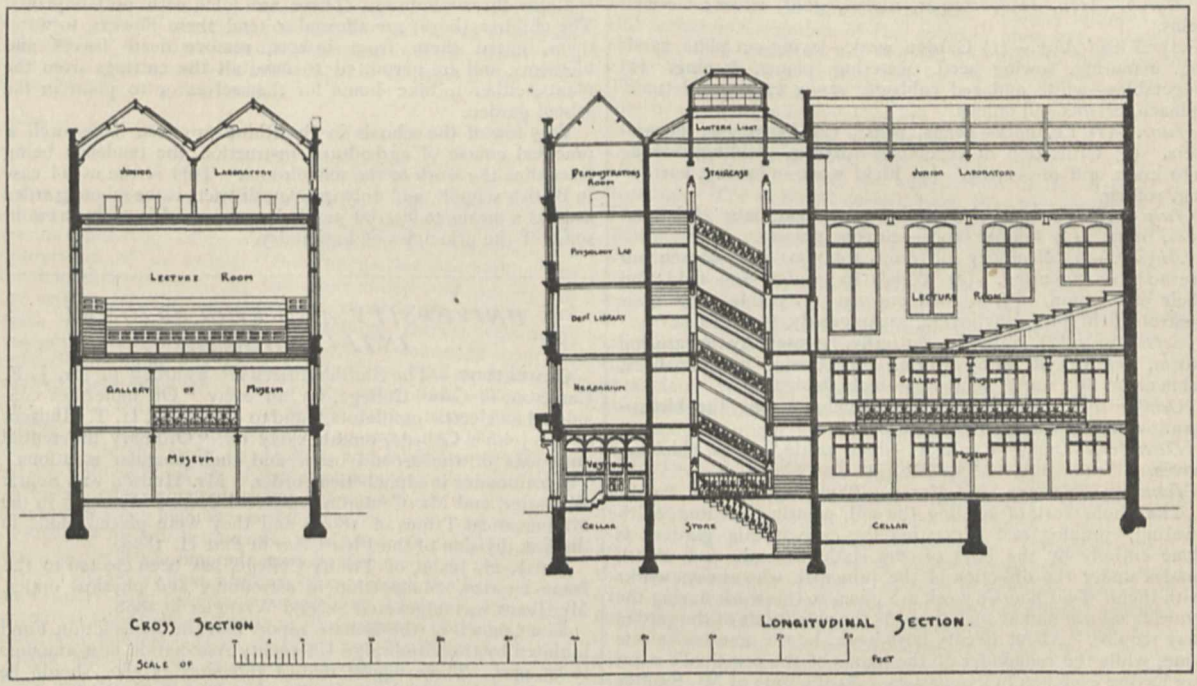
modating twelve students, as well as demonstrators' private room and laboratory.

On the roof there will be a small greenhouse with access from the junior laboratory.

The buildings will be lit throughout with electric light, and there will be electric bell and speaking-tube communication between the different private rooms, porter's room, and workshop.

The whole of the furniture and fittings have been designed by Professor Harvey Gibson and Mr. F. W. Dixon, the architect, so as to facilitate in every possible way the work both of students and teachers.

The furniture generally will be of pitch pine, and the cases of polished Canary wood. The staircase will have solid polished stone steps, and the walls will be plastered and painted. Externally the buildings will be faced with 2½-inch Ruabon brick with red sandstone dressings.



Hartley Botanical Laboratories, University College, Liverpool.

Altogether it may be said that Mr. Hartley's gift will provide University College, Liverpool, with a botanical laboratory worthy to stand alongside of the pathological and physiological laboratories, the recent splendid gift to the College of Mr. Thompson Yates. The building will be taken in hand immediately, and will, in all probability, be ready for occupation before the beginning of the autumn term of 1901.

SCHOOL GARDENS.

AS attention is being given to the question as to the subjects which should be taught in rural primary schools, and as the observation of living things under natural conditions is slowly coming to be regarded as an essential part of the education of a child in the country, a description of a course of instruction of this kind, given in a German elementary school, is of interest at the present time. Such an account, by Mr. C. B. Smith, has been published by the U.S. Department of Agriculture as *Circular* No 42, and is here summarised.

The school is situated at Alfter, a village of some 2000 inhabitants, in the German Rhine Province, between Bonn and Cologne, and is what is known as a "people's school," which is equivalent to our public elementary school. Only the fundamental branches are taught in these schools, and the whole course is completed in eight years.

The Alfter common school contains 400 pupils and six teachers. In this school, as in all others in this province, two hours' instruction weekly in fruit culture, gardening, and general farming during the last two years of the course is required. This has been compulsory by law since 1895. Outline suggestions for this work are sent the principal of the school by the provincial government, as follows:—

OUTLINE OF AGRICULTURAL COURSE IN THE HIGHER GRADES OF RURAL SCHOOLS IN THE GERMAN RHINE PROVINCE.

First Year.

April and May.—(1) Inner structure of plants; plant cells and tissues and their functions. (2) Outer divisions of plants: (*a*) The roots—their function in the nourishment of plants by the absorption of mineral matter, as phosphorus, potassium, sodium, iron, chlorine, and water; (*b*) the trunk—its branches and buds, the structure of the cambium, and the occurrence of ring growths.

June.—(1) The leaf; the nature and function of chlorophyll in the life of the plant and the effect of light on chlorophyll development; breathing of plants; nourishment of plants from atmospheric constituents—carbon, nitrogen, oxygen. (2) The blossom and its fertilisation. (3) The fruit; seeds; reproduction of plants by seeds and by division of members.

July.—(1) The soil and its improvement—lime soil, clay soil, loams, sand. (2) The using up of plant food and its replacement by barnyard manure, compost, wood ashes, and indirect manures, as lime and gypsum. (3) Influence of the climate on plants.

August.—(A) Fruit culture. (1) Planting and nursery management of seedlings. (2) The most important methods of fruit improvement—root and stem grafting and budding with active and dormant buds. (3) Management of improved seedlings in the nursery—formation of the trunk and top; transplanting; handling of trained trees, especially espalier forms, with reference to their training against schoolhouse walls. (4) Culture of small fruits—gooseberries, currants, raspberries, strawberries and blackberries; setting grape-vines and their afterculture.

September.—(B) Fruit utilisation. (1) Ripening of the fruit; gathering, sorting, and storing winter fruits. (2) Fruit varieties—selection of the more commendable sorts with regard to their suitableness to different climates and soils and at varying

altitudes. (3) Drying fruits; preserving; making fruit syrups; wine making. This work is planned especially for the girls.

October and November.—(C) Fruit-tree management. (1) Planting trees; pruning the roots and branches; watering newly-set trees and tying to stakes. (2) Care during the first year; top pruning. (3) Management of old trees—rejuvenating by pruning, grafting and scraping the bark. (4) Diseases of fruit trees and their prevention—knot growths, blights, gum excrescences, and frost injuries.

December.—(1) Enemies of fruit trees in the vegetable kingdom—mistletoe, mildew, lichens and moss. (2) Animal enemies of fruit trees—rabbit, mole, marmot.

January.—June bug; plum, apple and pear curculios; wasps; white butterfly; woolly aphis; and winter canker-worm.

February.—Minerals: soft coal; stone coal; petroleum; clay and its application in the manufacture of pottery and bricks; table salt.

March.—Iron, lead, copper, nickel, gold, silver; German coins.

April and May.—(1) Garden work—laying out plats, spading, manuring, sowing seed, watering plants, hoeing. (2) Vegetables—white and red cabbage, savoy cabbage, lettuce, spinach, carrots and onions.

June.—(1) Legumes—beans, peas. (2) Asparagus, cucumbers. (3) Utilisation of vegetables—drying, pickling, making into kraut and preserving. (4) Field work—plowing, harrowing, rolling.

July.—Field crops: (1) Cereals—rye, wheat, oats. (2) Potatoes, beets. (3) Fodder crops—clovers, grasses.

August.—(1) Necessity of crop rotation and consequent methods of manuring. (2) Weeds in garden and field and their eradication. (3) Animal enemies of plants and their control—field mice, phylloxera, asparagus fly, ground flea.

September.—(1) Cabbage butterfly, gooseberry measuring worm, pea weevil, army worm. (2) Useful insects: bees, ichneumon fly; useful mammals—mole, hedgehog.

October and November.—Plant enemies among the birds—swallow, nightingale, lark, robin, owls.

December.—Domestic animals—dogs, cattle, horses, chicken, doves.

January, February, and March.—Physiology of man.

The whole work of spading the soil, planting, seeding, cultivating, pruning and harvesting the crop in this garden, is done entirely by the boys of the sixth, seventh and eighth grades under the direction of the principal, who always works with them. Two hours a week are given to this work during the growing season and at such times as the conditions of the garden may require. About twenty boys work in the garden at one time, while the remainder of the pupils of the principal's room are having exercises in gymnastics. At the time of Mr. Smith's visit to this school a part of the pupils were sowing seed, others were covering them with soil to the required depth, while still others were laying out paths, picking off the dead leaves from flower stems, replanting beds, watering seeds already sown, &c. A few days later the fruits required attention; wall, espalier, and dwarf fruits require to be summer pruned, the fruits to be thinned, insects to be gathered and destroyed.

The children use the pruning shears and do the actual pruning, each pupil being given an opportunity to trim some portion of a tree; but no twig was allowed to be pruned until it was perfectly clear that that particular twig required pruning, and, indeed, to be pruned in a particular place which the pupil himself first determined upon. When it comes time for budding each pupil buds trees in the nursery. The fall pruning is always done by the children, and small fruits, vines and shrubs put in order for the winter by wrapping some with straw, laying others on the earth and covering, and the like.

The garden is intensively farmed and made a source of revenue. The same soil is utilised for two or three crops during the growing season and the produce sold. This gives the pupils an opportunity to learn what crops best form a succession with each other during the season, and also gives them practice in a limited way in preparing and putting up fruits, flowers, and vegetables for the market.

The principal is accustomed to walk through the garden each morning before school. Should he discover a harmful insect or disease, a specimen is immediately taken to the schoolroom and the nature and work of the injurious agent shown to the pupils and discussed. This enemy is especially hunted for during the following work hour, and the children are asked to search the gardens at home for similar insects or diseases. Thus by daily association with the garden, daily watching for every new development and daily discussions and explanations, all the phenomena of the garden are encountered and brought to the attention of the pupils before the year's cycle is at an end.

Occasionally the bees are made the subject of a special lesson in apiculture. One morning a hive swarmed and flew by the school window, alighting on a small tree. The school was taken to observe this phenomena. The queen was found among the mass of clustering bees and was placed in the hive, the workers were gathered and placed with her, and a new colony was formed. Work in the apiary is incidental, but no opportunity is lost to make available anything of an especially instructive nature concerned therewith, and in the nature work the history of bees is considered.

So likewise flowering plants in the school windows are incidentally made a means of instruction. The principal's room contains three windows. These are filled with potted plants. The children (boys) are allowed to tend these flowers, to water them, guard them from insects, remove dead leaves and blossoms, and are permitted to have all the cuttings from the plants, either to take home for themselves or to plant in the school garden.

Very few of the schools in the Rhine province have such a practical course of agricultural instruction, the tendency being to confine the work to the schoolroom. This is the usual case in British schools, and only in a few districts is the school garden used as a means to interest pupils in nature and instruct them in some of the principles of husbandry.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Smith's Prizes are awarded to Mr. J. F. Cameron, of Caius College, for an essay "On molecules considered as electric oscillators," and to Mr. R. W. H. T. Hudson, of St. John's College, for an essay on "Ordinary differential equations of the second order and their singular solutions." The names are in alphabetical order. Mr. Hudson was Senior Wrangler, and Mr. Cameron bracketed Second Wrangler in the Mathematical Tripos of 1898; and they were placed alone in the first division of the First Class in Part II. 1899.

Mr. J. H. Jeans, of Trinity College, has been elected to the Isaac Newton Studentship in astronomy and physical optics. Mr. Jeans was bracketed Second Wrangler in 1898.

The Council of the Senate report that the Benefaction Fund initiated by the Cambridge University Association now amounts to 55,430*l.* They suggest that of this sum 35,280*l.* should be appropriated to buildings for the departments of Botany, Law and Medicine, in addition to 8070*l.* specifically assigned to Law and Medicine by the donors.

Dr. J. N. Langley is to be appointed deputy-professor of Physiology for Sir Michael Foster, M.P., until Michaelmas 1901, at a stipend of 300*l.* a year.

Mr. F. G. Hopkins, University lecturer in Chemical Physiology, was admitted to the degree of M.A. *honoris causa* on March 1.

THE Council of Bedford College will in June next award an additional science scholarship, the "Henry Tate Scholarship," of the value of 50*l.* per annum for three years. This scholarship was endowed by the late Sir Henry Tate, and is to be for the first time awarded in science.

IN answer to a question asked by Sir Michael Foster in the House of Commons on Thursday last, Sir J. Gorst said the Government is fully alive to the importance of scientific teaching in secondary schools, and will take care that nothing is done in the organisation of the Board of Education to impede its efficiency and progress.

THE policy of the Michigan State Agricultural College, a report upon which is included in the Report of the Michigan Board of Agriculture just received, is to educate youths and young women for the farm, and to give them such knowledge and inspiration along the various lines of agricultural work as will induce them to follow this calling after leaving the College. When the College was opened forty years ago, many students

partially supported themselves by work upon the College farm during summer, and during the long winter vacation they taught district schools, thereby earning enough to pay their expenses at College. But conditions in Michigan have very much changed since that time, and the long vacation is not now in winter, as was formerly the case, but in summer. Students, who have not learned the ordinary operations of farm work before entering the College, have to spend one long vacation on the College farm. As the College farm and park cover an area of 676 acres, there is plenty of opportunity to study practical agriculture. The report of the Experimental Station provides the students and the farmers of the State with much useful information. The influence which the Station exerts upon the agriculture of the State may be estimated from the fact that more than 24,000 copies of the bulletins are distributed. These bulletins, which deal with such subjects as "Sugar Beets in Michigan," "Experiments in Corn Raising," "Commercial Fertilisers," "Bacteria and the Dairy," "Feeding Dairy Cows," "Injurious Insects," and "Tuberculosis in Cattle," are in no wise compilations, but records of results of original investigations; their value as a factor in the development of the agriculture of the State must be very important.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxii. No. 1, January.—Appareil à liquide pour l'intégration graphique de certains types d'équations différentielles, by M. Petrovitch, is a continuation of the article, "Sur l'intégration hydraulique des équations différentielles," by the same author (vol. xx. No. 4). The article describes an apparatus, exceedingly easy to construct, which gives a means of solving certain equations, "intégrables analytiquement, mais il est commode pour les applications d'avoir une methode rapide et sûre pour la construction mécanique de leurs courbes intégrales."—The next paper, proof that there is no simple group whose order lies between 1092 and 2001, by G. H. Ling and G. A. Miller, continues the search begun by Hölder, and carried on by F. N. Cole and Burnside.—T. F. Holgate contributes a note additional to a former paper on certain ruled surfaces of the fourth order. The surface for which the nodal lines are real and distinct, F_5^4, and that for which the nodal lines are coincident, F_6^4, were previously discussed, but no mention was made of the surface for which the nodal lines are imaginary, though the existence of such a surface must have been in mind at the time. From the geometrical standpoint a study of the separate surfaces is of considerable interest.—H. F. Stecker's non-Euclidian properties of plane cubics is an interesting discussion on the lines of Clifford and Story.—Dr. E. O. Lovett gives two notes (1) on the differential invariants of Goursat and Painlevé, and (2) a supplementary note on projective invariants (see the April No. of the last volume).—Certain sub-groups of the Betti-Mathieu group is a slight addition to a dissertation by Dr. L. E. Dickson (*Annals of Mathematics*, 1897; *cf.* also the July No. (1899) of the *American Journal*).—Dr. W. H. Metzger gives a brief note on the excess of the number of combinations in a set which have an even number of inversions over those which have an odd number.—On Lie's theory of continuous groups, by E. W. Rettger, following up Study's and Taber's work, investigates the two- and three-parameter sub-groups of the general projective group in two variables, and of the general homogeneous linear groups in three variables, enumerated by Lie on pp. 288, 519 of his *Continuerliche Gruppen*, and his aim is to show that singular transformations occur among the transformations of many of these sub-groups.—V. Snyder writes on lines of curvature on annular surfaces having two spherical directrices. Several interesting geometrical results are given.

Symons's Monthly Meteorological Magazine, February.—Climatological records for the British Empire for 1898. Of the eighteen representative stations from which observations are regularly received, the highest shade temperature was recorded at Adelaide, 113°·3 on January 11, and the lowest at Winnipeg, −34°·6 on December 31, with the greatest range in the year, 126°·1, the least being at Grenada, 19°·8. The driest station was Adelaide, mean humidity 59, and the dampest place, Colombo (Ceylon) and Trinidad, mean humidity 80. Adelaide also registered the highest temperature in the sun, 173°·7. The greatest rainfall occurred at Colombo, 103·1 inches, and the least, 15·6 inches, at Melbourne. The most cloudy place was London, the average amount being 6·4. The table shows a remarkable similarity to that for 1897; there are only three changes in the summary of extreme values. Malta, in 1898, had a rainfall (29·2 inches) nearly ten inches above the average of 15 years, and probably the greatest on record.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society.—Special meeting held by invitation of Prof. Callendar in the Physical Laboratory of University College, March 2.—Prof. G. Carey Foster, F.R.S., Vice-President, in the chair.—Dr. F. G. Donnan read a paper on the relative rates of effusion of argon, helium, and other gases. The introduction to this paper contains a short account of the work which has been done on the effusion of gases. This is followed by a theoretical investigation of the subject, upon the assumption that the ideal gas laws are obeyed, and that the back pressure never rises above a certain fraction of the internal pressure. This gives rise to formulæ which are different from the square root of the density law of Graham. The formula derived from Hugoniot and Reynold's work gives the ratio of the times of effusion of two gases whose specific heat ratios are 1·408 and 1·67, equal to 1·06 times the square root of the ratio of the densities. The constant derived from Parenty's work is 1·084. The theory therefore indicates that argon should effuse faster than would be calculated from Graham's law. The gases used were oxygen, hydrogen, nitrogen, carbon-mon-oxide, carbon-di-oxide, cyanogen, argon and helium, and they effused through small holes pierced in platinum foil. When the holes are large compared with molecular dimensions the phenomenon is one of efflux on a small scale. In the actual experiments this was the case, although the holes were sufficiently small to cause appreciable viscosity effects. By employing two or more observations in conjunction with the relative viscosities of the gases used, an apparatus constant was determined which allowed these effects to be eliminated. The observations showed that argon effused 3½ per cent. faster than as calculated from the densities alone. This agrees qualitatively with theory, and affords a confirmation of the high specific heat ratio of argon. Hydrogen, oxygen and carbon-mon-oxide effuse in the manner predicted by the theory for gases having the same, or nearly the same, specific heat ratios. Carbon-di-oxide when compared with oxygen appears to effuse 1 per cent. faster than as calculated from the densities. This result is not in accordance with the adiabatic theory of the efflux of ideal gases. The results for helium are not uniform, but show that its behaviour is unlike that of argon, a result not foreseen by the theory. If account be taken of the deviation of ordinary gases from the ideal laws, it is possible to obtain an expression for the efflux which contains a correction term involving the constant K of the Joule-Thomson effect. The sign of this correction term shows that a real gas will effuse more rapidly or more slowly than an ideal gas of equal density and specific heat ratio, according as K is positive or negative. The suggestion is made that possibly the anomalous results obtained with carbon dioxide and helium may be thus explained. The deviations of the observed results from the results calculated for an ideal gas are, in the case of carbon dioxide, in qualitative agreement with the theory proposed. In the case of helium, they would be so if that gas possesses a negative K.—Lord Rayleigh congratulated the author, and pointed out that in the case of very small apertures the gas laws might not be obeyed. The ratio of the dimensions of the aperture to the length of the mean free path determined this, and not the ratio of aperture to molecular dimensions.—Prof. Ramsay and Prof. Everett expressed their interest in the work.—Dr. Donnan thanked Lord Rayleigh for his correction, and stated that the apertures used were about $\frac{1}{10}$ mm. in diameter.—Mr. E. C. C. Baly read a paper on the distillation of liquid air and the composition of the gaseous and liquid phases. From the experiments described in this paper, the author has drawn curves showing the relation between the composition of the gas evolved by boiling liquid air and its temperature, and between the composition of the liquid and the temperature, both at constant (atmospheric) pressure. These curves enable the temperature of boiling liquid air to be at once accurately determined by means of an analysis either of the liquid or of the gas evolved. The measurements of temperature

were made with a Callendar compensated constant pressure hydrogen thermometer. The correction for the contraction of the glass bulb was determined by measuring directly the linear expansion of glass between − 190° C. and 20° C. This was found to be ·0000073, Regnault's measurement between 0° and 10° being ·0000085. The values for the boiling points of oxygen and nitrogen agree fairly well with those given by Olszewski and Estreicher. Boiling nitrogen has a great tendency to superheat. This can be obviated by passing a rapid current through the boiling liquid, or by dropping in pieces of copper. There does not appear to be any connection between the ratio of the vapour-pressures and the composition of the gaseous phase in the distillation of oxygen and nitrogen at constant pressure. It is proposed to investigate the distillation at constant temperature. Prof. Ramsay drew attention to the uses of liquid air for carrying on researches at low temperatures. It is non-explosive, easy to work with, and is easily kept either by means of a vacuum jacket or by surrounding it with cotton-wool. Prof. Callendar referred to the question of superheating, and stated that the constant pressure thermometer was more accurate than the constant volume one for measuring low temperatures.—A paper on the reversibility of galvanic cells, by Mr. T. S. Moore, was read by Dr. Lehfeldt. In these experiments the reversibility of cells, such as the Daniell and the Clark, which are assumed to be reversible, was tested by allowing the cell to send a current, and by sending a current through the cell. The E.M.F.'s of the cells were determined by means of a Crompton potentiometer, and from the E.M.F.'s on open and closed circuits the internal resistances of the cells were calculated. Prof. S. P. Thompson asked if experiments had been made upon Leclanché cells where the products of the action escape. Dr. Lehfeldt said that experiments were not made upon these cells because they were known not to be reversible.—A paper on the damping of galvanometer needles, by Mr. M. Solomon, was postponed until the next meeting.

Zoological Society, February 20.—Dr. Henry Woodward, F.R.S., Vice-President, in the chair.—Mr. Oldfield Thomas exhibited a specimen of a kangaroo from Northern Australia allied to *Macropus eugenii*, but distinguished by its pale colour and long soft fur. It was proposed to name the species *M. bedfordi*, after the Society's President, who had given the specimen to the British Museum.—Mr. Thomas also exhibited a kangaroo from Western Australia, apparently referable to *Macropus robustus*, but separable sub-specifically by its nearly uniform rufous fawn-colour. It was named *Macropus robustus cervinus*.—Mr. R. Lydekker exhibited, on behalf of Mr. Rowland Ward, the horns and skins of a male and female, in the winter coat, of the sheep which, on the evidence of specimens in the summer dress, he had recently named *Ovis sairensis*.—Mr. Lydekker also exhibited, on behalf of Mr. Rowland Ward, the skull, horns, and skin of a remarkable ibex obtained in the Altai, which he was inclined to refer provisionally to *Capra sibirica dauvergnei*.—Mr. C. W. Andrews gave a brief account of the land fauna and the general physical features of Christmas Island, accompanied by some lantern illustrations. He then read a paper on the marine fauna of that island, and pointed out that, the conditions being unfavourable, no systematic attempt to collect marine animals had been made, but that, nevertheless, a certain number of specimens had been obtained, which were enumerated and described in this paper by various specialists. Mr. E. A. Smith had determined twenty-seven species of Mollusca, all common Indo-Pacific forms. Of the corals Mr. H. M. Bernard had described about twenty-two species, referable to fifteen genera, two of them, viz. *Goniastraea auricularis* and *Montiporo spongilla*, being new. The sponges had been determined by Mr. R. Kirkpatrick, and were referred to thirty-one species and twenty-four genera, of which six new species and two new varieties were described. From sand dredged from a depth of eleven fathoms Mr. F. C. Chapman had determined twenty-four species of Foraminifera.—Mr. R. Lydekker communicated a paper by Dr. Einar Lönnberg, of Upsala, containing the results of the dissection of the soft parts of several specimens of the musk-ox (*Ovibos moschatus*), obtained in Greenland during the recent Swedish Expedition under the direction of Prof. Nathorst. The result of his observations was to indicate that this animal could not be regarded as a member of the Caprine group, while it was equally widely separated from the *Bovinae*. In the absence of a knowledge of the soft parts of the Takin (*Budorcas*), the author was unable to accept the suggested affinity of the musk-ox with that animal. Consequently, for the present at least, it might be regarded as representing a subfamily by itself.—Mr. F. E. Beddard read a paper on the anatomy of an earthworm, *Benhamia caecifera*, a specimen of which he had lately had sent to him from Ashanti. This species had been described by Dr. Benham in 1895, chiefly from external characters, no detailed account of its internal structure having been given.—A paper was read by Mr. Oldfield Thomas on the mammals obtained by Mr. H. J. Mackinder during his recent expedition to Mount Kenya, British East Africa. Fourteen species from the mountain were enumerated, besides five others specimens of which had been obtained at Niarobi. Three species of Dassy (*Procavia*) were described: one (*P. jacksoni*) from the Eldoma Ravine, like *P. abyssinica*, but with coarser fur and more prominent dorsal spot; a second (*P. mackinderi*) from the alpine zone high up on Mount Kenya, like *P. jacksoni*, but larger and with much longer fur; and a third (*P. crawshayi*) from the forests at the foot of Mount Kenya, allied to *P. valida*, but more rufous and with a whitish dorsal spot.

Linnean Society, February 15.—Mr. C. B. Clarke, F.R.S., Vice-President, in the chair.—Mr. R. Morton Middleton, exhibited a series of specimens of *Asplenium Bradleyi*, Eaton, one of the rarer rock ferns from Tennessee, to show its extreme variability. The simplest fronds exhibited were found in a damp, cold, perpendicular rift, which no sunshine could enter, at an elevation of about 1700 feet; these fronds had the simple pinnate structure, with green rhachis and rounded, toothed pinnæ of *A. viride*, Hudson, but were more coriaceous than in that species. Dr. Gattinger, author of the "Tennessee Flora," was satisfied that the plant was *A. viride;* and General Kirby Smith, who had had ample opportunity of studying *A. Bradleyi* on the eastern slopes of the Cumberland Plateau, remarked that *A. viride* and *A. Bradleyi* were so much alike that they might be varieties. The other plants exhibited, however, showed a gradual tendency to become more and more compound, culminating in a luxuriant specimen with pinnatifid fronds 10 inches long, the green rhachis becoming purple and shining in all the plants exposed to the sun's rays.—Mr. J. C. Shenstone exhibited a collection of 700 photographs of British flowering plants, to show what could be accomplished by means of the camera in the direction of botanical illustration. He contended that photography was the only means by which the lines and masses of our flowering plants, as truly characteristic as the less subtle characters by means of which botanists group and arrange plants into orders, genera and species, could be readily reproduced. He explained the various technical processes and apparatus necessary for successful plant photography, and alluded to the difficulties inseparable from the photography of plants in their natural habits, &c. His remarks were illustrated by means of lantern-slides.—The Zoological Secretary gave an account of a paper by Dr. R. F. Scharff, Keeper of the Natural History Collections in the Science and Art Museum, Dublin, describing a Land Planarian discovered by the author in the Pyrenees during the autumn of 1899, which he had named *Rhynchodesmus Howesi*. The paper contains a description of the leading facts of structure of the worm, which is a colossal representative of the genus to which it belongs, since it measures 130 millim. in length—*i.e.* twice that of the largest species of the genus hitherto known. It was found at Eaux Chaudes, 2000 feet above sea-level, coiled round the shell of a *Helix nemoralis*, which it had overcome and was about to devour.—Mr. J. B. Carruthers exhibited specimens and lantern-slides to illustrate the growth of the vegetable canker *Nectria ditissima* on the cocoa-plant, and gave an account of certain experiments which he had made to destroy it without injury to the tree which it attacked.

CAMBRIDGE.

Philosophical Society, February 5.—Mr. Larmor, President, in the chair.—Ionisation of gases in an electric field, Prof. J. J. Thomson. The view put forward in this paper is that the ionisation of a gas in an electric field is brought about by the presence of ions already in the field. These ions move under the electric force and acquire energy which can be spent in ionising the gas. It is shown that this view would explain why an electric field of definite strength is required to produce discharge, why a thin layer of gas is electrically stronger than a thick one, why the electric strength diminishes with the pressure of the gas until a critical pressure is reached when the strength is a minimum, as well as many phenomena connected with the discharge through gases at low pressure.—On differential equations with two independent variables, Dr.

A. C. Dixon. The results include those of Hamburger's paper (*Crelle's Journal*, vol. xciii.), but are somewhat wider in application and point to a further generalisation.—On the calculation of the double integral expressing normal correlation, W. F. Sheppard. When the measures of two organs vary about their mean value according to the normal law, and the statistical correlation of the two sets of variations is also normal, the frequency of joint variation within any selected imits is expressed by the integral considered in the paper.—On the hemihedrism and twinning of crystals of Dolomite from the Binnenthal, R. H. Solly. Mr. Solly exhibited a number of crystals with diagrams and models to explain the hemihedrism and twinning. Some new forms were notified.—Apparatus for measuring the extension of wires, G. F. C. Searle. Two wires *A*, *B* are hung side by side from the same support; the apparatus is designed to measure the extension of *B* relative to *A*, which is treated as a standard. To the lower ends of *A* and *B* are attached the upper ends of two brass frames *C*, *D*, and from the lower ends of these frames there hang respectively a constant weight and a scale pan. The two frames are kept parallel by a pair of links so arranged that the frames are capable of small relative vertical displacements. To the frame *C* is pivoted one end of a spirit level, of which the other end rests upon the end of a screw working in a nut fixed to *D*. When a load is placed in the pan hanging from *D*, the wire *B* is stretched and the bubble of the level is displaced. To bring the bubble back to its zero position the screw must be advanced through a distance which is exactly equal to the extension of the wire *B*. In this manner an extension of 1/1000 millimetre can be detected. With copper wire it is possible to detect hysteresis when the maximum extension is only 1/100 per cent. of the total length.—Magnetic disturbances in the Isle of Skye, Alfred Harker. It has long been known to climbers that in the Cuillin Hills the compass often becomes useless as a guide. On examination it is found that the most violent disturbances are localised at the summits and salient points on the ridges, and are due to intense permanent magnetisation with a curiously irregular distribution in the mass of the rock. This is ascribed to atmospheric electricity. It is found not only in the Cuillins, but equally on the moorland hills which make up all the north-western half of Skye; the gabbro of the former tract and the basalt of the latter are both rocks rich in iron. It is next shown that areas sometimes hundreds of yards in extent exhibit disturbances of a lower order, but still easily verified with a pocket-compass. Such an area includes one or more centres of violent local disturbance, and there appear to be evident relations between the two orders of phenomena. Finally, it is suggested that much smaller and more widespread disturbances, such as those revealed by Rücker and Thorpe's magnetic survey, may also be referable to permanent magnetisation of the rocks. The alternative hypothesis of induction seems inadequate in view of the known geological constitution of the district.

PARIS.

Academy of Sciences, February 26.—M. van Tieghem in the chair.—On the law of diurnal rotation of the optical field furnished by the siderostat and heliostat, by M. A. Cornu. It is shown that the rotation of the field has the same period as the diurnal movement, and is continuous and always in the same sense. The field of vision of the siderostat remains absolutely stationary when the polar distance of the star under examination is equal to the supplement of the polar distance of the reflected direction; the field of the heliostat, when it can be used, turns with an angular velocity which is always greater than that of the daily movement.—On the composition of hydrofluoric acid by volume, by M. Henri Moissan. Preliminary attempts were made to make fluorine act directly upon a known volume of hydrogen, but as the reaction proved to be too vigorous, the fluorine was passed into water and the liberated oxygen, after being freed from ozone by heating, measured. The fluorine and hydrogen were found to be evolved on electrolysis in exactly equal volumes.—Study of the serotherapy of anthrax, by M. S. Arloing. Experiments carried out with the serum upon sheep show that unless the serum is injected immediately after infection with anthrax, no curative effects are produced, thus rendering the serum of little practical value. Great differences were noticed in the effects when the injection of the serum was made at different places, one cubic centimetre in the veins having the same effects as ten times this amount injected into the conjunctive tissue.—The new observatory of Tananarive, by M. R. P. Collin.—The Perpetual Secretary announced to the Academy the loss it had sustained by the death of M. Eug. Beltrami, Correspondant for the Section of Mechanics.—Observations of the Giacobini comet (January 31, 1900), made at the Observatory of Paris with the 30·5 cm. equatorial, by M. G. Bigourdan.—Observations of the Giacobini comet (1900, *a*) made at the Observatory of Besancon, by M. P. Chofardet.—On the application of nomography to the prediction of occultations of stars by the moon, by M. Maurice d'Ocagne.—On the method of Neumann and the problem of Dirichlet, by M. A. Korn.—On the fundamental kinematic equations of varieties in space of *n* dimensions, by M. N. J. Hatizidakis.—On the movement of light waves and the formulæ of Fourier, by M. Gouy. A discussion of some recent papers of M. Carvallo upon the same subject.—The interpretation of the thermomagnetic effect in the theory of Voigt, by M. G. Moureau.—Remark on a recent note of M. Th. Tomasina on the metallic crystallisation by electrical transport of certain metals in distilled water, by M. D. Tommasi. A reclamation of priority.—The association of molecules in liquid bodies, by M. Daniel Berthelot. The author applies his modified Van der Waal's formula, in which the co-volume is regarded as a function of the temperature, to determine the coefficient of association of liquids at the critical point. For methyl, ethyl and propyl alcohols this coefficient is clearly greater than unity, a fact which has been previously pointed out by Dr. S. Young.—Oxidation by means of ferricyanides. Oxidation of camphor, by M. A. Étard. The action of potassium ferricyanide in alkaline solution is regarded by the author not as an addition of oxygen, but a simple loss of hydrogen. Camphoric acid is readily produced from camphor by this reagent.—On the anhydrous dimercurammoniun iodide in its amorphous and crystalline forms, by M. Maurice Francois.—On the estimation of ammonia and of nitrogen, by MM. A. Villiers and E. Dumesnil. The ammonia is distilled into an excess of hydrochloric acid, evaporated to dryness, heated for twenty hours at 105°, and weighed as ammonium chloride. It was found that even if the period of final drying was prolonged to seventy-two hours, no loss of weight occurred.—On the chemical equilibrium of a system in which four gases are present, by M. H. Pélabon. The formulæ developed were tested experimentally by a study of the interaction of mercury selenide and hydrogen at a temperature of 540° C. The influence of pressure upon the constant obtained, which in this case was considerable, was also studied.—On the contaminated waters of the wells of Guillotière and Brotteaux at Lyons, by M. H. Causse. From the water from these sources, which has caused typhoid fever, cystine was isolated.—Elimination of sodium cacodylate by the urine after absorption through the stomach, by MM. H. Imbert and E. Badel.—A new colour reaction of tyrosine, by M. G. Denigès. Tyrosine treated with aldehyde in a solution strongly acidified with sulphuric acid, yields a condensation derivative possessing a fine rose carmine colour, with a characteristic absorption spectrum.—On the rotatory power of active valeric acid, by M. Ph. A. Guye and Miss E. Aston.—On the plurality of species in the cultivated red currant, by M. Ed. de Janczewski.—On the parasitism of *Phoma reniformis*, by MM. L. Ravaz and A. Bonnet. The authors conclude that the spores of *P. reniformis* cannot be the primary cause of the vine disease in the Caucasus.—Examination of the fossils collected in China by the Leclère mission, by M. H. Douvillé.—On the Oligocene of the region between Issoire and Brioude, by M. J. Giroud.—The denudation of the whole of the Lorraine plateau, and on some of its consequences, by M. Bleicher.—On the comparative delivery of the two kidneys, by MM. E. Bardier and H. Frenkel.—Action of high-tension currents of high frequency upon chronic pulmonary tuberculosis, by M. E. Doumer. Considerable improvement followed the application of these currents to tuberculous subjects, the nocturnal sweats being reduced after the fifth or sixth application, and disappearing completetly after the fifteenth. The feverish symptoms are reduced in about the same time, the appetite commencing to improve after the fifteenth application. The expectoration became less abundant, and in the few cases that were systematically examined the number of bacteria diminished. Occasionally, however, the numbers would increase again. Sufficient time has not yet elapsed to be able to speak of the permanency of the improvements noted.—The treatment of tuberculous infection by muscular plasma, or zomotherapy, by MM. J. Héricourt and Charles Richet. Curves are

given showing the relative effects of cooked and uncooked meat as a diet for the tuberculous, the active part of the meat consisting of the parts soluble in water.

AMSTERDAM.

Royal Academy of Sciences, January 27.—Prof. H. G. van de Sande Bakhuyzen in the chair.—Prof. J. C. Kapteyn explained a new method of determining the direction of the sun's motion in space, and criticised the methods of Argelander, Airy and Kobold.—Prof. Van der Waals made a communication concerning the cooling down of a gas current on the pressure being suddenly lowered.—Prof. Franchimont presented to the Library of the Academy the dissertation of Dr. P. J. Montagne, entitled "The action of strong nitric acid upon the three isomeric chloro-benzoic acids and some of their derivatives," and orally elucidated the contents of this work.—The following papers were presented for publication in the *Proceedings*:—(*a*) By Prof. Van der Waals; first, on behalf of Mr. Hamburger, a paper, entitled "Lipolytic ferment in human ascitic fluid." Secondly, a paper by Mr. H. Hulshof, entitled "The direct deduction of the value of the molecular constant σ considered as tension in the surface." (*b*) By Prof. Kamerlingh Onnes, a paper, entitled "Methods and apparatus employed in the Cryogene Laboratory (II.). Mercury pump for compressing pure and expensive gases at high pressure." (*c*) By Mr. E. F. van de Sande Bakhuyzen, on behalf of Mr. C. Sanders, a paper on the determination of the geographical latitude of Ambriz and of San Salvador in Portuguese West Africa. (*d*) By Prof. Bakhuis Roozeboom; first, on behalf of Dr. Ernst Cohen, a paper, entitled "The supposed identity of red and yellow mercury monoxide (II.)," and secondly, on behalf of Dr. A. Smits, a paper on "Determination of the decreases of the tension of solution vapours by means of determining the rises of the boiling point." (*e*) By Prof. Jan de Vries, a paper, entitled "On twisted Quintics of deficiency one."—A treatise by Prof. Schoute, entitled "Les hyperquadriques dans l'espace à quatre dimensions (Étude de géométrie énumerative)" was presented for publication in the Academy's *Transactions*.

DIARY OF SOCIETIES.

THURSDAY, MARCH 8.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: The Specific Heat of Metals and the Relation of Specific Heat to Atomic Weight: Prof. W. A. Tilden, F.R.S.

ROYAL INSTITUTION, at 3.

MATHEMATICAL SOCIETY, at 8.—On the Use of the Curve of Error as an Auxiliary Curve in Statistics with Tables: W. F. Sheppard.—Problems relating to the Impact of Waves on a Spherical Obstacle in an Elastic Medium: Prof. Lamb, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—On the Applications of Electricity in Medical and Surgical Practice: Dr. H. Lewis Jones.

CAMERA CLUB, at 8.—Steam Turbines, Land and Marine: A. A. Campbell Swinton.

FRIDAY, MARCH 9.

ROYAL INSTITUTION, at 9.—Bacteria and Sewage: Prof. Frank Clowes

ROYAL ASTRONOMICAL SOCIETY, at 8.—Photographic Observations of Hinel's Variable Nebula in Taurus, made with the Crossley Reflector of the Lick Observatory: Prof. J. E. Keeler.—Ephemeris for Physical Observations of the Moon for the Second Half of 1900: A. C. D. Crommelin.—On a Simple Method of Comparing the Bonn Durchmusterung with Photographic Plates: Prof. H. H. Turner, F.R.S.—The Maximum Duration possible for a Total Solar Eclipse: C. T. Whitmell.—Note on a Possible Occultation of A Geminorum on 1900 May 27-28: W. W. Bryant.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Distribution of Stress in the Walls of a Thick Cylinder: John Duncan, W. A. Wales, and G. J. Day.

PHYSICAL SOCIETY at 5.—On the Damping of Galvanometer Needles: M. Solomon.—On the Distribution of a Gas in an Electric Field: G. W. Walker.—Exhibition of a Surface Tension Lecture Experiment: C. E. S. Phillips.

MALACOLOGICAL SOCIETY, at 8.—Further Notes on Helicoid Landshells from Japan, the Loo Choo and Bonin Islands, with Description of New Species: G. K. Gude.—Note on the Genera *Callocardia* and *Vesicomya*: E. A. Smith.—The Genus *Mytilus* and its South American Species: H. von Jhering.

MONDAY, MARCH 12.

SOCIETY OF ARTS, at 8.—The Photography of Colour: E. Sanger Shepherd.

TUESDAY, MARCH 13.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Stone Circles of Scotland: A. L. Lewis.—Exhibit of Photographs of Megalithic Buildings in Malta and Gozo: J. L. Myres.

INSTITUTION OF CIVIL ENGINEERS, at 8.—A Short History of the Engineering Works of the Suez Canal: Sir Charles Hartley, K.C.M.G.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Illumination of Developing Rooms: E. Howard Farmer.

THURSDAY, MARCH 15.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Total Eclipse of the Sun, January 22, 1898. Observations at Viziadrug: Sir N. Lockyer, K.C.B., F.R.S., Captain Chisholm-Batten, R.N., and Prof. Pedler, F.R.S.—A Comparative Crystallographical Study of the Double Selenates of the Series $R_2M(SeO_4)_2.6H_2O$. Part I. Salts in which M is Zinc: A. E. Tutton, F.R.S.—The Theory of the Double Gamma Function: E. W. Barnes.

ROYAL INSTITUTION, at 3.—Recent Excavations in Greece: Dr. C. Waldstein.

LINNEAN SOCIETY, at 8.—Report on the Botanical Results of an Expedition to Mount Roraima, in British Guiana, undertaken by F. V. McConnell and J. J. Quelch, W. Botting Hemsley, F.R.S., and others.—Bryozoa from Franz Josef Land, collected by the Jackson-Harmsworth Expedition, 1896-97: A. W. Waters.

CHEMICAL SOCIETY, at 8.—The Vapour Densities of Dried Mercury and Mercurous Chloride: H. Brereton Baker.—(1) The Preparation of Pure Hydrobromic Acid; (2) A New Sulphide of Arsenic: Dr. A. Scott, F.R.S.—The Action of Iodine on Alkalis: R. L. Taylor.—The Interaction between Sulphites and Nitrites: Dr. Edward Divers, F.R.S., and Dr. Tamemasa Haga.—New Polysaccharides: Manno-galactan and Lævulo-mannan: Julian L. Baker and Thomas H. Pope.

FRIDAY, MARCH 16.

ROYAL INSTITUTION, at 9.—Pictorial Historical Records: Sir Benjamin Stone.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Measles: its Distribution and Control: Dr. Robinson.

SATURDAY, MARCH 17

ROYAL INSTITUTION, at 3.—Polarised Light: Lord Rayleigh.

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